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Environmental Assessment of Buccaneer Gas and Oil Field in the Northwestern Gulf of Mexico 1978-1979. Volume II

(U.S.) National Marine Fisheries Service
Galveston, TX

Prepared for

Environmental Protection Agency
Washington, DC

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J.M. Brooks, E.L. Estes, and W.H. Huang / (Texas A&M Univ., College Station)

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16. ABSTRACT

Water column samples were taken at stations around two production platforms and near a well jacket and flare stack in the Buccaneer Oil Field during summer, fall, winter and spring periods (1978-1979). Large seasonal variations in the suspended load of the water column were observed. During the winter, concentrations of total suspended matter (TSM) were significantly higher than in other seasons. The Buccaneer Field productions platforms do not measurably alter the bulk composition of suspended particulates or biological activity in their immediate vicinity. These results were to be expected, considering the small volumes discharged by the platforms (i.e., from brine, oil spillage, etc.) compared against the large volume of water transported through the field. Pollutants introduced into the water column from the platforms could be rapidly transported out of the system either because of hydrographic conditions or perhaps by attachment to suspended particulates. Once out of the field, rapid dilution would obscure their presence and diminish their effect. Contaminants introduced to the sediments may be rapidly removed from the platform vicinity by suspension and redeposition. (Author modified)

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VOL. II - INVESTIGATIONS OF SURFICIAL SEDIMENTS AND SUSPENDED PARTICULATES AT BUCCANEER FIELD

BY J. M. Brooks, Ph. D., E. L. Estes, Ph. D.
and W. H. Huang, Ph. D.

Texas A&M University
Dept. of Oceanography
College Station, Texas 77843

A report to the Environmental Protection Agency on work conducted under provisions of Interagency Agreement EPA-IAG-D5-E693-E0 during 1978-1979.

EDITORS
William B. Jackson
Senior Advisor
Contracts & Deliverables
and
E. Peter Wilkens
Fishery Biologist

U. S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary

National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator

National Marine Fisheries Service
Terry L. Leitzell, Assisistant Administrator for Fisheries

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Volume II - SEDIMENTS AND PARTICULATES

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II. Principal Investigators' Section

Work Unit 2.3.2 Investigations of Surficial Sediments and Suspended Particulates at Buccaneer Field. xxiv

PROJECT ADMINISTRATION

NOAA

Program Manager

W. Lawrence Pugh
Oceans Program Office
Rockville, Maryland

NMFS

Contracting Officer's Technical Representative

Edward F. Klima, Ph.D.
Director
Galveston Laboratory
Southeast Fisheries Center

Project Manager

Charles W. Caillouet, Ph.D.
Chief, Environmental Research Division

Project Staff (Environmental Research Division)

William B. Jackson
Senior Advisor
Contracts and Deliverables

Gregg R. Gitschlag
Senior Advisor
Field Operations and Logistics

E. Peter H. Wilkens
Fishery Biologist

Gary M. Faw
Fishery Biologist

Robert M. Avent, Ph.D.
Oceanographer

Dennis Koi
Computer Programmer

Petronila C. Prado
Clerk Stenographer

Mary Taylor
Clerk Typist

Patsy Hunter
Clerk Typist

Susan Gray
Clerk Typist

Beatrice Richardson
Clerk Typist

Leesa Young
Biological Aide

Julie Mellen
Student Aide

Richard Devereux
Coop. Student Biologist

LIST OF VOLUMES

This Annual Report is printed in ten separate volumes:

Volume I - SYNOPSIS/DATA MANAGEMENT

Work Unit 2.6.1	Synopsis NMFS/SEFC Galveston Laboratory Principal Investigators
Work Unit 2.2.3	Implement, Monitor, and Modify Data Management System NMFS/SEFC National Fisheries Engineering Laboratory K. Savastano H. Holley

Volume II - SEDIMENTS AND PARTICULATES

Work Unit 2.3.2	Investigations of Surficial Sediments and Suspended Particulates at Buccaneer Field Texas A&M University J. Brooks, Ph.D. E. Estes, Ph.D. W. Huang, Ph.D.

Volume III - FISHES AND MACROCRUSTACEANS

Work Unit 2.3.5	Effect of Gas and Oil Field Structures and Effluents on Pelagic and Reef Fishes, Demersal Fishes, and Macrocrustaceans LGL Ecological Research Associates, Inc. B. Gallaway, Ph.D. L. Martin

Volume IV - BACTERIA

Work Unit 2.3.7 Bacterial Communities

University of Houston

R. Sizemore, Ph.D.
K. Olsen

Volume V - FOULING COMMUNITY

Work Unit 2.3.8 Effects of Gas and Oil Field Structures and Effluents on Fouling Community Production and Function

LGL Ecological Research Associates, Inc.

R. Howard
G. Boland
B. Gallaway, Ph.D.
G. Dennis

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Hazleton Environmental Sciences Corporation

L. Danek, Ph.D.
M. Tomlinson

Volume VII - HYDROCARBONS

Work Unit 2.4.1 Hydrocarbons, Biocides, and Sulfur

University of Houston

B. Middleditch, Ph.D.
D. West

Volume VIII - TRACE METALS

Work Unit 2.4.2	Trace Metals Southwest Research Institute J. Tillery

Volume IX - FATE AND EFFECTS MODELING

Work Unit 2.5.1	Sources, Fate and Effects Modeling Science Applications, Inc. K. Fucik, Ph.D. I. Show, Ph.D.

Volume X - HYDRODYNAMIC MODELING

Work Unit 2.5.2	Hydrodynamic Modeling Environmental Research and Technology, Inc. G. Smedes, Ph.D. J. Calman J. Beebe

GUIDE TO USERS OF THE ANNUAL REPORT

Volume I (SYNOPSIS/DATA MANAGEMENT) of the Annual Report is designed to be used as a briefing document and as a key to more detailed scientific and technical information contained in Volumes II through X. Objectives, methods and results for each work unit are summarized in greatly abbreviated form within Volume I to facilitate dissemination of information. Thus, Volume I can be used alone or as a reference to companion Volumes II through X. Complete citations for literature cited in Volume I can be found in the Volumes II through X in which the detailed work unit reports are presented.

It is hoped that such an approach to environmental impact information dissemination will make the Annual Report a more useful and widely read document.

FOREWORD

Increased petroleum development of the outer continental shelf (OCS) of the United States is anticipated as the U.S. attempts to reduce its dependency on foreign petroleum supplies. To obtain information concerning the environmental consequences of such development, the Federal Government has supported major research efforts on the OCS to document environmental conditions before, during, and after oil and gas exploration, production, and transmission. Among these efforts is the *Environmental Assessment of Buccaneer Gas and Oil Field in the Northwestern Gulf of Mexico*, a project funded by the Environmental Protection Agency (EPA) through interagency agreement with the National Oceanic and Atomospheric Administration (NOAA) and managed by the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFC), Galveston Laboratory, in Galveston, Texas. Initiated in the autumn of 1975, the study is now in its last year. Its major products have been annual reports disseminated by the National Technical Information Service, data files archived and disseminated by NOAA's Environmental Data and Information Service, and research papers written by participating investigators and published in scientific or technical journals. Results have also been made available through EPA/NOAA/NMFS project reviews and workshops attended by project participants, and various governmental (Federal and State), private, and public user groups. The final products will be milestone reports summarizing the findings of the major investigative components of the study.

Objectives of the project are (1) to identify and document the types and extent of biological, chemical and physical alterations of the marine ecosystem associated with Buccaneer Gas and Oil Field, (2) to determine specific pollutants, their quantity and effects, and (3) to develop the capability to describe and predict fate and effects of Buccaneer Gas and Oil Field contaminants. The project uses historical and new data and includes investigations both in the field and in the laboratory. A brief Pilot Study was conducted in the autumn and winter of 1975-76, followed by an extensive biological/chemical/physical survey in 1976-77 comparing the Buccaneer Gas and Oil Field area with adjacent undeveloped or control areas. In 1977-78, investigations were intensified within Buccaneer Gas and Oil Field, comparing conditions around production platforms, which release various effluents including produced brine, with those around satellite structures (well jackets) which release no effluents. In 1978-79, studies around Buccaneer Gas and Oil Field structures focused on (1) concentrations and effects of pollutants in major components of the marine ecosystem, including seawater, surficial sediments, suspended particulate matter, fouling community, bacterial community, and fishes and macro-crustaceans, (2) effects of circulation dynamics and hydrography on distribution of pollutants, and (3) mathematical modeling to describe and predict sources, fate and effects of pollutants. The final year, 1979-80, of study is continuing to focus on items (1) and (2) and on preparation of the milestone reports which will represent the final products of this study.

This project has provided a unique opportunity for a multi-year investigation of effects of chronic, low-level contamination of a marine ecosystem associated with gas and oil production in a long-established field. In many respects, it represents a pioneering effort. It has been made possible through the cooperation of government agencies, Shell Oil Company (which owns and operates the field) and various contractors including universities and private companies. It is anticipated that the results of this project will impact in a significant way on future decisions regarding operations of gas and oil fields on the OCS.

Charles W. Caillouet, Project Manager
Chief, Environmental Research Division
and
William B. Jackson and E. Peter Wilkens
Editors

LIST OF REPORTS AND PUBLICATIONS

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INTRODUCTION

Location of Study Area

The area selected for study is the operational Buccaneer Gas and Oil Field located approximately 49.6 kilometers (26.8 nautical miles) south southeast of the Galveston Sea Buoy off Galveston, Texas (Figure 1). This field was selected in 1975 as the study area because: (a) the field had been in production for about 15 years, which time had allowed full development of the associated marine communities; (b) it was isolated from other fields which facilitated the selection of an unaltered area (for comparison) within a reasonable distance of the field; (c) it produced both gas and oil that represented sources of pollutants from marine petroleum extraction; (d) its location simplified logistics and reduced the cost of the research; and (e) the Texas offshore area had not been fully developed for gas and oil production but was expected to experience accelerated exploitation in the future.

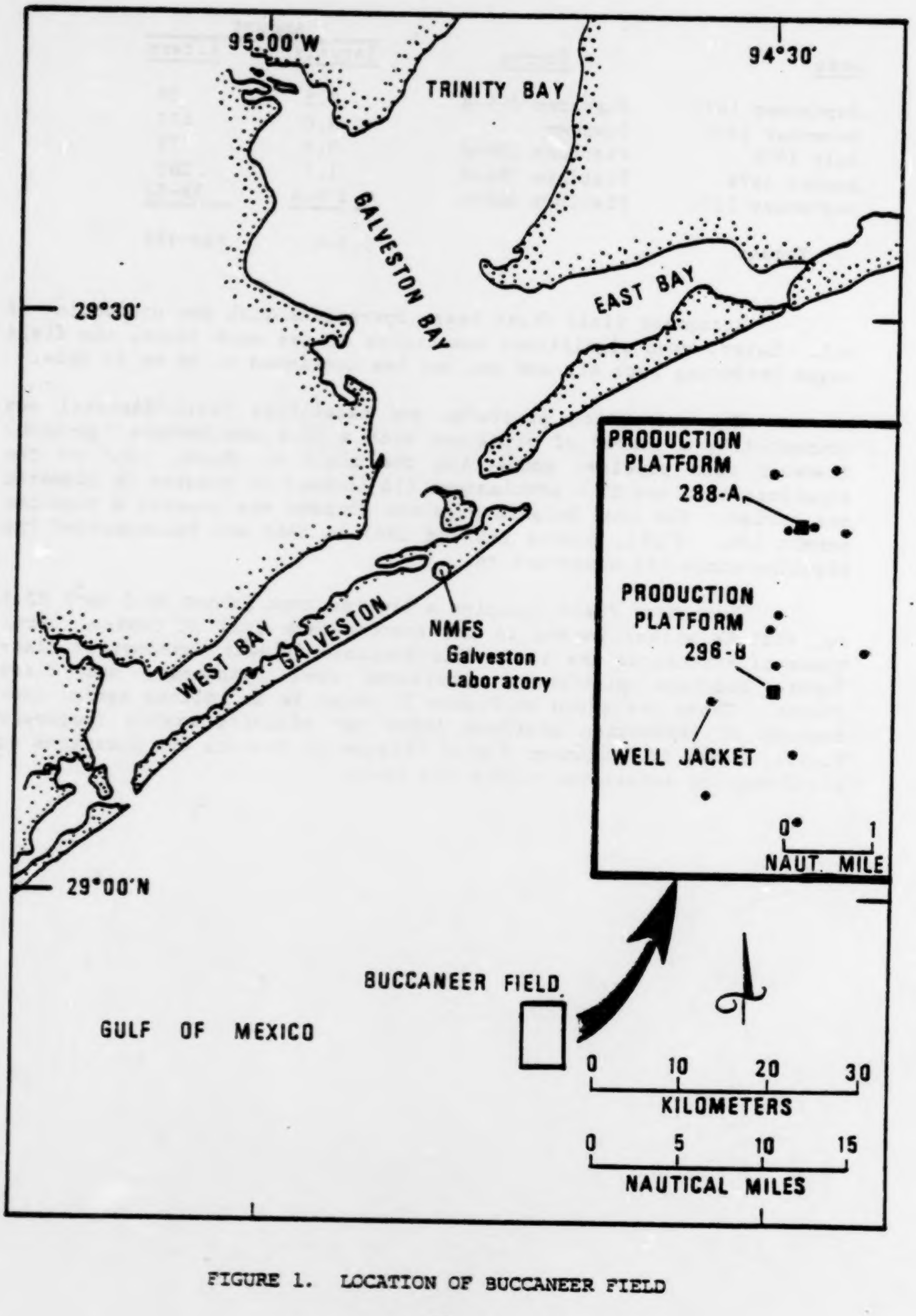
Operation History of Buccaneer Field

Buccaneer Field was developed by Shell Oil Company in four offshore blocks leased in 1960 and 1968 as follows:

Year	Lease Number	Block Number	Acreage	Hectares
1960	G0709	288	2,790	1,129
1960	G0713	295	4,770	1,930
1960	G0714	296	4,501	1,821
1968	G1783	289	2,610	1,056

In development of the field, 17 structures were built; two are production platforms, two are quarters platforms, and 13 are satellite structures surrounding well jackets. Initial exploratory drilling began about mid-summer of 1960 with mobile drilling rigs. When (as the result of the exploratory drilling) proper locations for platforms were selected, the permanent production platforms were constructed.

There have been no reports of major oil spills from this field. There have been some reported losses of oil due to occasional mechanical failure of various pieces of equipment. The largest reported spill was three barrels in 1973. The reported oil spill chronology and quantity for Buccaneer Field is as follows:



95°00'W
94°30'
TRINITY BAY
GALVESTON BAY
EAST BAY
29°30'
WEST BAY
GALVESTON
NMFS
Galveston
Laboratory
PRODUCTION
PLATFORM
288-A
PRODUCTION
PLATFORM
296-B
WELL JACKET
0
1
NAUT. MILE
29°00'N
BUCCANEER FIELD
GULF OF MEXICO
0
10
20
30
KILOMETERS
0
5
10
15
NAUTICAL MILES

FIGURE 1. LOCATION OF BUCCANEER FIELD

Date	Source	Amount Barrels	 Liters
September 1973	Platform 296-B	0.5	79
November 1973	Unknown	3.0	477
July 1974	Platform 296-B	0.5	79
August 1974	Platform 296-B	1.7	265
September 1975	Platform 288-A	0.2-0.4	38-56
Totals		5.9-6.1	938-956

Buccaneer Field first began operations with the production of oil. Later, when significant quantities of gas were found, the field began producing both oil and gas and has continued to do so to date.

The production platforms and satellites (well jackets) are connected by a number of pipelines with a 50.8 centimeters (20-inch) diameter main pipeline connecting the field to shore. All of the pipelines that are 25.4 centimeters (10 inches) or greater in diameter are buried. The Blue Dolphin Pipeline Company was granted a pipeline permit (No. G1381, Blocks 288 and 296) in 1965 and has operated the pipeline since its construction.

Buccaneer Field occupies a limited area (about 59.3 km^2; 22.9 sq. statute miles) leased in the northwestern Gulf of Mexico. Four types of structures are located in Buccaneer Field: production platforms, quarters platforms, satellites (well jackets), and flare stacks. These are shown in Figure 2, which is an oblique aerial photograph of production platform 288-A and vicinity within Buccaneer Field. A map of Buccaneer Field, (Figure 3) depicts the locations of platforms and satellites within the field.

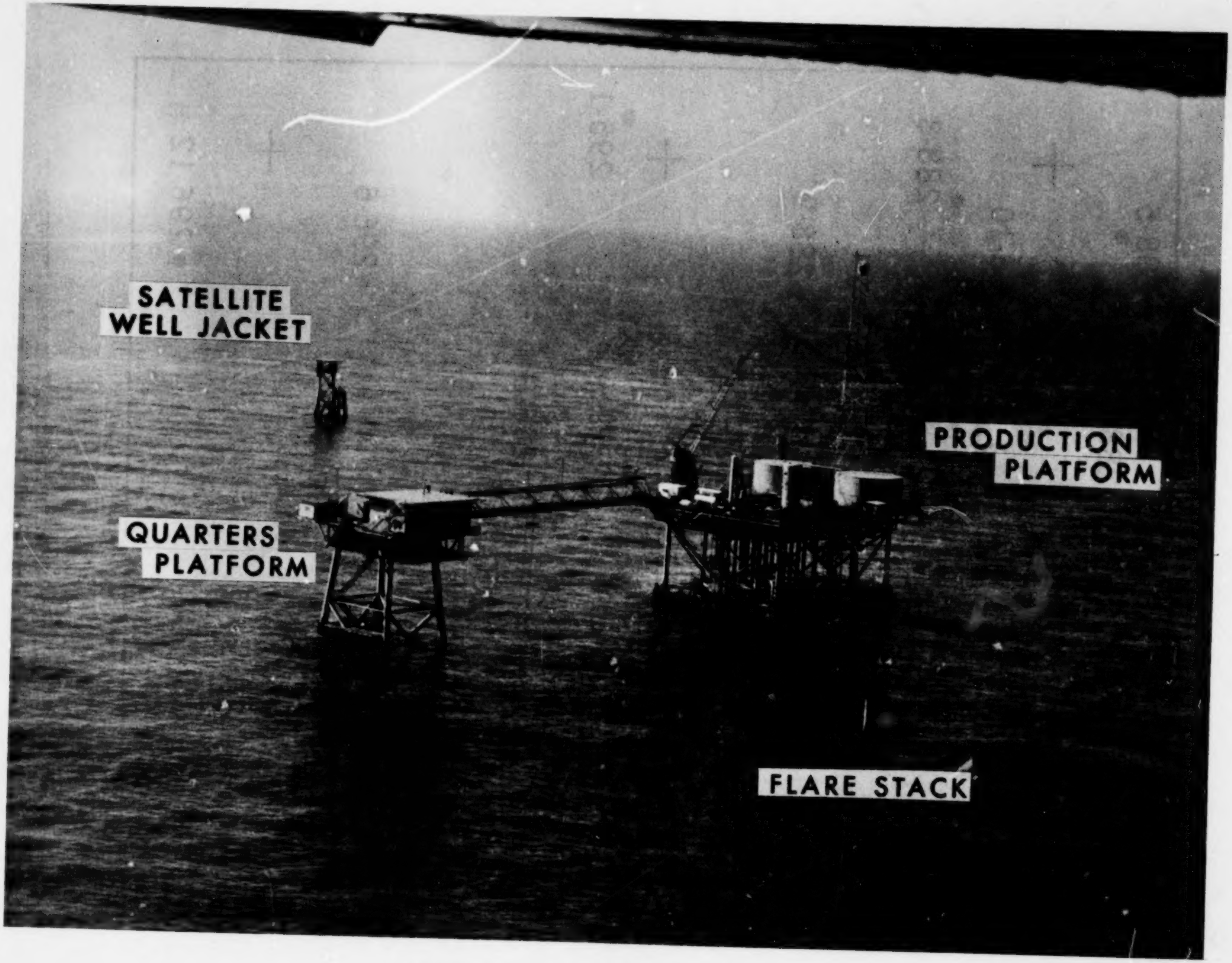

SATELLITE
WELL JACKET
QUARTERS
PLATFORM
PRODUCTION
PLATFORM
FLARE STACK

FIGURE 2. BUCCANEER FIELD STRUCTURES

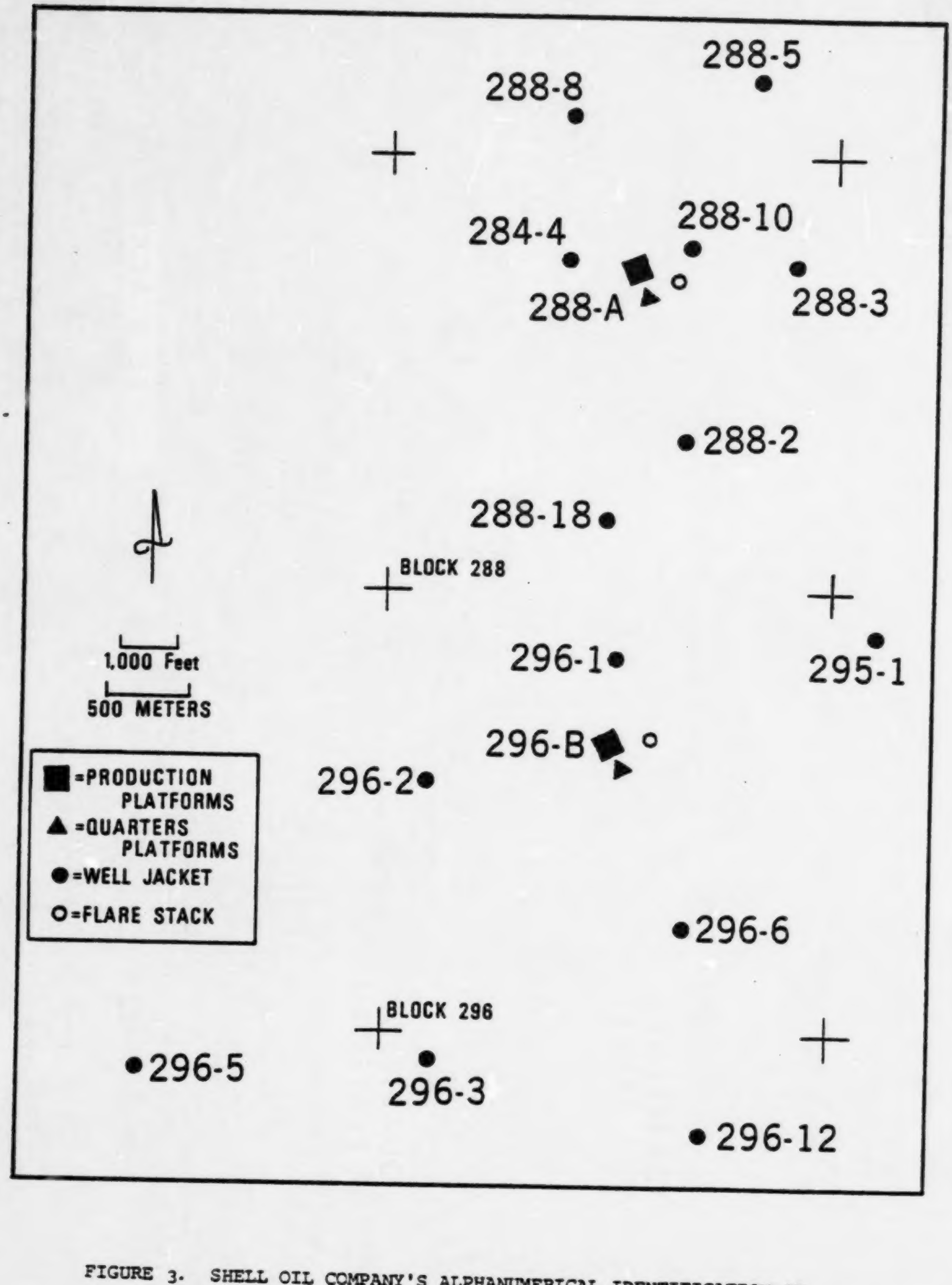

288-5
288-8
284-4
288-10
288-A
288-3
288-2
288-18
BLOCK 288
296-1
295-1
1,000 Feet
500 METERS
296-B
296-2
■ =PRODUCTION PLATFORMS
▲ =QUARTERS PLATFORMS
● =WELL JACKET
○ =FLARE STACK
296-6
BLOCK 296
296-5
296-3
296-12

FIGURE 3. SHELL OIL COMPANY'S ALPHANUMERICAL IDENTIFICATION OF BUCCANEER GAS AND OIL FIELD STRUCTURES

WORK UNIT 2.3.2 - INVESTIGATION OF SURFICIAL SEDIMENTS AND SUSPENDED PARTICULATES AT BUCCANEER FIELD

Texas A&M University

J. M . Brooks, Ph.D.
E. Estes, Ph.D.
W. Huang, Ph.D.

EXECUTIVE SUMMARY

Water column samples were taken at stations around two production platforms and near a well jacket and flare stack in the Buccaneer Oil Field during summer, fall, winter and spring periods (1978-1979). To characterize suspended particulates at these stations, analyses were made of total suspended matter (TSM), particulate organic carbon (POC), chlorophyll a, adenosine-triphosphate (ATP), calcium carbonate ($CaCO_3$), silicate, carbon isotopes, particle size and clay mineralogy and transmissometry. Nutrients and dissolved organic carbon (DOC) were also determined on the waters. Surficial sediment samples were analyzed for organic carbon, $CaCO_3$, clay mineralogy, particulate size and carbon isotopes. Pb-210 dating was performed on six cores to provide an estimate of the sedimentation rate.

Large seasonal variations in the suspended load of the water column were observed. During the winter, concentrations of TSM were significantly higher than in other seasons. The TSM load was uniform throughout the water column during the winter sampling period. This phenomenon was expected since the winter overturn of water in this area had already occurred. In the spring, a very large surface nepheloid layer was observed. This feature results due to freshwater runoff from coastal bays and estuaries. Mid-depth nepheloid layers were characteristic of the spring and fall sampling period. Near-bottom nepheloid layers resulting from resuspension of bottom

sediments were found during all sampling periods except winter. The seasonal changes in suspended particulates in this area seemed to reflect changes in currents and mixing patterns.

Clay was the dominate particulate material in the water column during all seasons. The majority of the inorganic fraction was in the 2-5 mm size range. The organic fraction consisted almost exclusively of cellular material (phytoplankton, zooplankton, and/or bacteria). Only in surface waters during the winter and spring were concentrations (~4-8 %) of particulate, non-cellular carbon observed. In all samplings except winter, cellular material constituted ~20-30 % of the suspended particulates. In the winter, due to a dramatic increase in phytoplankton productivity after overturn, suspended organic material constituted almost 50 % of the TSM. This high organic load resulting from winter planktonic activity is a dominant feature in this area. High productivity during the winter also increased the dissolved organic carbon in the water column by 50 %. Most other DOC concentrations throughout the year were around 1.2 ± 0.2 mgC/L. POC in the winter was essentially all phytoplankton. During other samplings, phytoplankton contituted less than 15 % of the cellular material.

The Buccaneer Field production platforms do not measurably alter the bulk composition of suspended particulates or biological activity (as measured by chlorophyll a and ATP) in their immediate vicinity. These results were to be expected, considering the small volumes discharged by the platforms (i.e., from brine, oil spillage, etc.) compared against the large volume of water transported through the field. Pollutants introduced into the water column from the platforms could be rapidly transported out of the system either because of hydrographic conditions or perhaps by attachment to suspended particulates. Once out of the field, rapid dilution would obscure their presence and diminish their effect.

Suspended particulate data indicates that the water column was stratified during all samplings except winter. During the summer and fall samplings, a strong pycnocline resulting from temperature stratification apparently existed in the field and inhibited transport of surface-introduced contaminates to the bottom. The winter water column was throughly mixed, due to strong turbulent activity. The water column was again well stratified during the spring sampling, apparently due to a surface fresh water lense characterized by high suspended particulate levels. The stratification of the water column during the majority of the year, no doubt, acts as a barrier against introduction of platform contaminants to the sediments near the platforms. Platform derived contaminants in the water are rapidly removed from the field.

The sedimentation rate in the field, based on Pb-210 dating, varies from 1.5 to 2.1 mm/yr in the northern part of the field, and from 3.5 to 3.7 mm/yr in the southern portion. The higher sedimentation rates may reflect local current patterns or resuspension and deposition of sediments by the platforms.

A decreasing gradient in organic and inorganic carbon away from the platform was observed. This sequence would be expected if a higher degree of productivity is associated with the platform. A general decrease in grain size with increasing distance from the platform was also found. The sediments range from extremely poorly sorted to poorly sorted. Sorting increases with distance away from the platforms. A scouring effect appears to be present to the south and west of the platforms. In the sediments, quartz is the predominate mineral, followed by carbonate.

Contaminants introduced to the sediments in the Buccaneer field may be rapidly removed from the platform vicinity by suspension and redeposition. Surficial sediment data indicate that there is considerable movement of the fine grain material in the area. Direction of sediment transport appears to be controlled by seasonal current patterns. Near-bottom nepheloid layers observed during all seasons also indicates that fine grained surficial sediments within the field are in a continued state of resuspension and reworking. Only contaminants associated with very coarse grained material would be expected to remain permanently in the field.

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1. INTRODUCTION

1.1 BACKGROUND

Although extensive offshore oil and gas development has occurred in the outer continental shelf (OCS) areas of Texas and Louisiana, few multidisciplinary programs have been undertaken to study the environmental consequences of such development. One of the few programs to study the effects of Gulf of Mexico petroleum development is the "Environmental Assessment of the Buccaneer Oil and Gas Field in the Northwestern Gulf of Mexico". This program, initiated in 1975, is funded by the Environmental Protection Agency through interagency agreement with the National Oceanic and Atmospheric Administration and managed by the National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory in Galveston, Texas. Objectives of the project are (1) to identify and document the types and extent of biological, chemical and physical alterations of the marine ecosystem associated with Buccaneer Oil Field, (2) to determine specific pollutants, their quantity and effects, (3) and to develop the capability to describe and predict fate and effects of Buccaneer Oil Field contaminants. This report is part of third year studies around Buccaneer Oil Field focusing on investigations of surficial sediments and suspended particulate matter.

The Buccaneer program is unique in that an extended multidisciplinary study was undertaken around this isolated oil field in the northwestern Gulf of Mexico. Although the Bureau of Land Management has undertaken several large baseline studies (South Texas and MAFLA areas) along the Upper Gulf Coast, they undertook only one 1-year platform study in 1978-1979. This program surveyed a large number of platforms, principally on the Louisiana shelf, instead of concentrating efforts at one field. Most other environmental studies around platforms have been fragmentary in that only narrow components of the environment or ecosystem have been investigated. This study provides an unique opportunity for long-term study of effects of chronic, low-level exposure of the marine ecosystem associated with an established field to various oil field associated contaminants.

1.2 PURPOSE

The objective of this study was to determine sediment distribution and suspension rates of the various fractions of the particulate material within the Buccaneer field. This investigation involved: (1) sampling of surficial sediments to determine particle size distribution, clay mineralogy, carbonate content, organic carbon content, and sedimentation rates by Pb-210 dating; (2) estimates of the phytoplankton standing crop via chlorophyll *a*; (3) estimates of living biomass via ATP measurements; and (4) characterization of the suspended load of the water column through determination of total suspended matter, transmissometry, clay mineralogy, particle size, organic carbon, carbonate, and nutrients. These parameters were sampled four times at seasonal intervals over the study.

This study gives further insight into the origin, flux, and distribution of sediments within the Buccaneer field. An assessment of the effects of offshore structures on these sediment processes may provide insight into the transport of anthropogenic compounds in the system. The information derived from this study is useful to benthic biological investigations and is important to the hydrocarbon and trace metal studies involving transport of these possible contaminants within the study area. This study is essential to an understanding of the ecological consequences of offshore oil/gas production since (1) suspended matter can be expected to act as a means of transport of absorbed contaminants, (2) inputs of large amounts of brines may affect the suspended load of the water at the site which can greatly affect the biota, (3) the presence, absence, and/or seasonality of a near-bottom nepheloid layer at the site will greatly affect the benthic community, and (4) measurements of biomass and ATP at stations in the study area may establish whether the brine is having any adverse affects on the primary producers at the site.

1.3 STUDY SITE

The Buccaneer Oil Field is located approximately 50 km south southeast of the Galveston sea buoy (Figure 1.1). The field was selected because: (1) the field had been in production for about 15 years allowing for full development of oil-field-associated marine communities; (b) it is isolated from other fields; (c) it produces both oil and gas; (d) its location simplified logistics; and (e) the Texas offshore area had not been fully developed for gas and oil production. The field was developed by the Shell Oil Company in four blocks of land that were leased in 1960 and 1968. In the development of the field, 17 structures have been built; two are production platforms, two are quarters platforms, and 13 are satellite structures surrounding well jackets. This study involved investigations of the two production platforms, one well jacket (288-5) and the flare stack off platform 296-B.

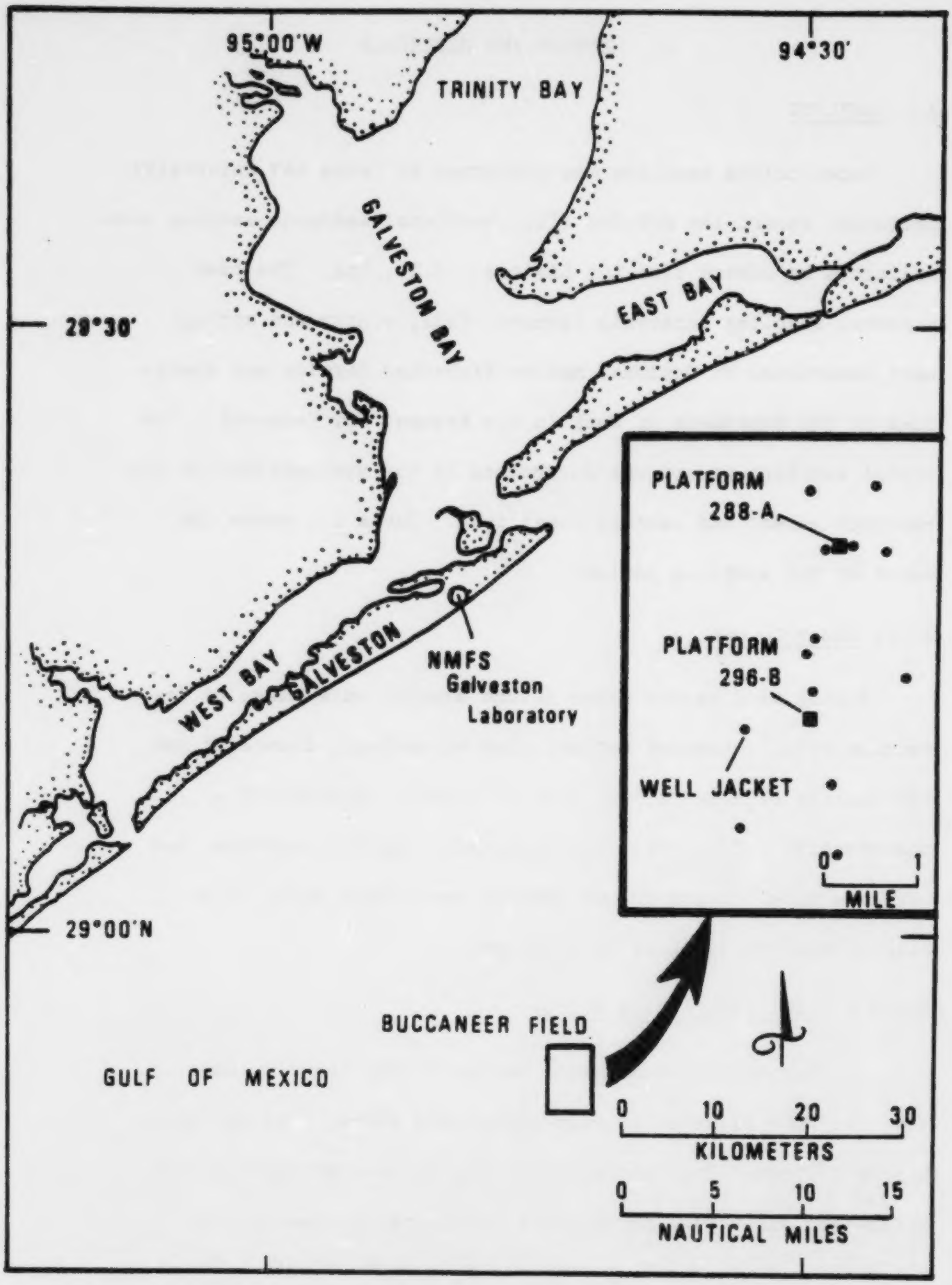
95°00'W
94°30'
TRINITY BAY
GALVESTON BAY
EAST BAY
29°30'
PLATFORM
288-A
PLATFORM
296-B
WELL JACKET
0
1
MILE
WEST BAY
GALVESTON
NMFS
Galveston
Laboratory
29°00'N
BUCCANEER FIELD
GULF OF MEXICO
0
10
20
30
KILOMETERS
0
5
10
15
NAUTICAL MILES

Figure 1.1 Location of Buccaneer Oil Field.

2. METHODS AND MATERIALS

2.1 SAMPLING

Water column sampling was performed by Texas A&M University personnel aboard the R/V Gus III. Surficial sediment samples were collected by divers from LGL Limited - U.S., Inc. The four seasonal sampling intervals (summer, fall, winter and spring) were determined by National Marine Fisheries Service and specified by the Statement of Work in the Request for Proposal. The actual sampling period was determined by the availability of the contract vessel and weather conditions. Table 2.1 gives the dates of the sampling periods.

2.1.1 Water Column

During each season water column samples were taken to determine total suspended matter, clay mineralogy, dissolved and particulate organic carbon, ATP, $\delta^{13}C$[POC], chlorophyll a, phaeophytin, $CaCO_3$, silicate, phosphate, nitrate, nitrite, and particle size. Water column samples were taken using large Niskin samplers (12 L or 30 L volume).

2.1.1.a Total Particulate Matter

For total suspended matter measurements, known volumes of seawater were filtered through preweighed 47-mm, 0.40 μm Nuclepore filters. The filters were weighed in quadruplet before filtration and stored in dust-free containers. Samples for all particulate parameters were drawn from the Niskin bottles

Table 2.1

WATER COLUMN AND SURFICIAL SEDIMENT SAMPLING PERIODS

Season	Dates
	Water Column
Summer	17-19 August 1978
Fall	29-31 October 1978
Winter	18-20 February 1979
Spring	28-30 May 1979
	Sediments
Summer	31 August 1978
Fall	1 September 1978
Winter	18-19 December 1978
Spring	May 1979

immediately upon retrieval from the hydrowire so that settling of particules within the sampling bottle would not lead to erroneous results. The amount of water needed for filtration was largely dependent on the particulate load of the water. After filtration the filters were rinsed with distilled, deionized water to remove all salt and then stored in dust-free containers in a desiccator until re-weighing. Each container was labeled with sample number and volume of water filtered.

2.1.1.b Transmissometry

The continuous suspended material distribution was determined by a Martek Model XMS "In Situ" Transmissometer lowering at each station. The instrument measures the light transmittance through a 1-meter light path in the water column. This instrument provided a continuous profile of the suspended matter distribution from the surface to near-bottom at each station. The transmissometer was calibrated assuming an 85 % light transmittance in clean air. The transmissometer was then lowered into the water and percent light transmittance plotted versus depth on an X-Y recorder. Each trace was labeled and stored for later analysis.

2.1.1.c Dissolved Organic Carbon

Dissolved organic carbon (DOC) was determined following the method of Fredericks and Sackett (1970). Samples for organic carbon determinations were transferred from Niskin samplers into duplicate glass-stoppered 1-liter reagent bottles. The bottles were stored in the dark until analysis. Aliquots of sample water were filtered through precombusted 25 mm Gelman Type A glass fiber filters. A vacuum of 330 mm Hg pressure was used in the filtration process to prevent rupturing of planktonic material. The filtrate was frozen for laboratory analysis.

2.1.1.d Particulate Organic Carbon

Particulate organic carbon (POC) sampling procedures were similar to dissolved organic carbon. Two 1-liter or smaller aliquots of seawater were filtered within 1 hour of sample collection through precombusted glass fiber filters. One filter was placed in each of two ampoules and frozen for laboratory analysis. Each ampoule was labeled with a station designation and volume of water filtered. Filter blanks were also prepared to insure noncontamination.

2.1.1.e Chlorophyll a

Three hundred ml of seawater obtained from the Niskin samplers was filtered through GF/C glass filters (4.5 cm diameter). The filters were desiccated, wrapped in aluminum foil, and frozen with appropriate designations.

2.1.1.f Adenosine Triphosphate

Samples for ATP analysis were filtered onto 0.40 μm, 47-mm Nuclepore filters. Immediately after filtration the filters were placed in vials with 5-ml of boiling Tris-buffer for 5 minutes. The vials with filters were labeled and frozen at -20°C until analysis.

2.1.1.g Calcium Carbonate

Samples for $CaCO_3$ determination were filtered through 47-mm, 0.45 µm Nuclepore filters. The samples were brought back to the laboratory in dust-free containers.

2.1.1.h Nutrients

Sampling involved placing unfiltered aliquots of seawater into 6-oz Whirl-Pak plastic containers and freezing until analysis. Samples for dissolved SiO_2 were filtered through 0.45 µm glass fiber filters.

2.1.1.i Particle Size Distribution

A 250 ml sample of seawater was collected in acid-washed polypropylene bottles and labeled appropriately. Water samples taken for particle size analysis were not frozen or dried before particle size analysis. All samples were delivered to Moody College Sediment Laboratory for analysis.

2.1.1.j Clay Mineralogy

Water samples were filtered through 0.45 micron Millipore filters until the filter was clogged or the available water used. Prior to the filtration, the system was flushed with 500 ml of sample water. After filtration was completed, each filter was rinsed with ten ml of deionized water to remove salts. The filters were removed from the filter heads, placed in clearly labeled covered petri dishes and refrigerated at 4°C for shipment.

2.1.1.k Stable Carbon Isotopes (organic)

Milligram quantities of particulate material were filtered onto pre-combusted 0.45 μm glass fiber filters for analysis of stable carbon isotopes. After filtration the filters were rinsed with distilled, deionized water to remove all salt and then stored in dust-free containers in a desiccator until re-weighing. Each container was labeled with sample number and volume of water filtered.

2.1.2 Surficial Sediments

Surficial sediments were collected by divers using one liter wide mouth plastic jars. All samples were stored cool or frozen until analysis. Samples were split in the laboratory for organic carbon, calcium carbonate, carbon isotope, clay mineralogy and particle size determinations.

Separate cores were taken for Pb-210 dating. Those cores were taken using a lined gravity core. The plastic liner containing the core was capped, labeled and frozen. In the laboratory the core was extruded and sectioned in 1 cm intervals for analysis.

2.2 ANALYTICAL PROCEDURES

2.2.1 Water Column

2.2.1.a Total Particulate Matter

Filters from the field were freeze-dried to ensure they were moisture-free. Successive weights were determined on the filters until constant weights were obtained. Weights were also determined on filter blanks prepared along with sample filters. TSM measurements are reported in milligrams material per liter of seawater (mg/L).

2.2.1.b Transmissometry

Transmissometry profiles were brought to the laboratory for calibration against standard TSM measurements. The profiles were then ready for interpretation. Transmissometry is reported as percent light transmittance plotted versus depth.

2.2.1.c Dissolved Organic Carbon

Ten-ml of the filtrate was placed with 0.2 mg of oxident ($K_2S_2O_8$) and 0.25 ml of 6% H_3PO_4 in each of three 10-ml glass precombusted ampoules. The ampoules were purged of inorganic carbon and sealed. The sealed ampoules were heated for 24 hours at 100°C to convert the organic carbon to CO_2. The carbon dioxide content of each ampoule was determined on a Total Carbon System Analyzer (Oceanography International Corp.) by flushing the gaseous contents of the ampoule with nitrogen into the gas stream of a nondispersive infrared analyzer sensitized to CO_2. DOC concentrations were determined in triplicate and corrections made for reagent blanks. Concentrations are reported as milligrams carbon per liter of water (mgC/L). Accuracy and precision are generally better than a few percent.

2.2.1.d Particulate Organic Carbon

Similar analytical procedures were used as with DOC, except that concentrations were corrected for filter blanks instead of reagent blanks. POC concentrations were determined in duplicate and reported as milligrams carbon per liter of water (mgC/L). Because of the greater variability in organic particulate samples from one replicate sample to the next, precision is generally ±5%.

2.2.1.e Chlorophyll a

Chlorophyll and its degradation product phaeophytin were measured using a Turner Fluorometer (Model 111) following the method as described by Yentsch and Menzel (1963) and Holm-Hansen *et al.* (1965). Concentrations of chlorophyll a and phaeophytin are reported to ±0.002 mg/m^3.

2.2.1.f Adenosine Triphosphate

Samples were stored frozen at -20°C until analysis. The ATP was determined by the technique of Holm-Hansen and Booth (1966) using a JRB Inc., ATP Photometer. The appropriate blanks and standardization curves were run to determine actual concentrations of high energy bonds. ATP concentrations are reported as nanograms per liter of sea water (ng/L).

2.2.1.g Calcium Carbonate

Calcium carbonate was determined for the summer samples using a Craig (1953) type system. The same system was also used to determine organic carbon in sediments. The procedure basically involved placing the filter containing the suspended matter in a side-arm evacuation flask. One arm of the flask contains the filter while the other contains 5 ml of phosphoric acid. The flask is cadmium reductor column and determined by difference (Kamphake et al., 1967; E.P.A., 1971; Armstrong et al., 1967).

Phosphate was determined by reaction with ammonium molybdate and potassium antimonyl tartrate in acidic medium to form an antimony-phosphomolybdate complex. This complex is reduced by ascorbic acid to an intensely blue colored complex which is proportional to the phosphorus concentration (Murphy and Riley, 1962).

The analysis of silicates was based on the reduction of a silicomolybdate in acidic solution to molybdenum blue by ascorbic acid. Oxalic acid was introduced to the sample stream before the addition of ascorbic acid to eliminate interference from phosphates (Brewer and Riley, 1966).

2.2.1.i Particle Size Distribution

Filtered suspended particle sample size distribution was determined by optical microscopy.

2.2.1.j Clay Mineralogy

Filters which contain particulates were first rinsed thoroughly with deionized water to remove residual salts. The particulates were then resuspended and filtered through Selas Flotronic Silver membranes (0.45 μ pore size and 25 mm diameter) for X-ray diffraction analysis. If the suspended load was high, two differently orientated mounts were made. In order to obtain a complete analysis of both clay and non-clay minerals in particulates, the samples were first

X-rayed without treatment, and then X-rayed following various treatments with ethylene glycol or glyceral, and heating (Huang, 1976). Relative percentages of clay and non-clay minerals were determined on a semi-quantitative basis, following the method as described by Huang (1975).

2.2.1.k Stable Carbon Isotopes

Carbon isotope ratios were determined on particulate organics. Filters containing known weights of particulate material were placed in ceramic or metal combustion boats and treated with dilute hydrochloric acid to eliminate inorganic carbon. After redrying the samples on a hot plate at low heat, each was combusted in the Craig (1953) type system pictured in Figure 2.1. Not indicated, is the copper oxide at 900°C and silver wool inside the quartz tube in furnace F to catalyze the conversion of CO to CO_2 and to remove SO_2 from the combustion product gases, respectively, and a separate tube containing copper metal at 500°C which reduces nitrogen oxides in the product gases to nitrogen gas which is then separated from condensed CO_2 (at liquid nitrogen temperatures) by evacuation. Removal of nitrogen and sulfur oxides is necessary for precise organic carbon determinations. The entire combustion procedure was as follows:

The system was pressurized to the atmosphere and the combustion boat was introduced into the quartz tube inside F followed by a glass enclosed iron rod. The tube was evacuated, an aliquot of pure oxygen gas added, the Toepler pump (TP) started to cycle the oxygen gas and,

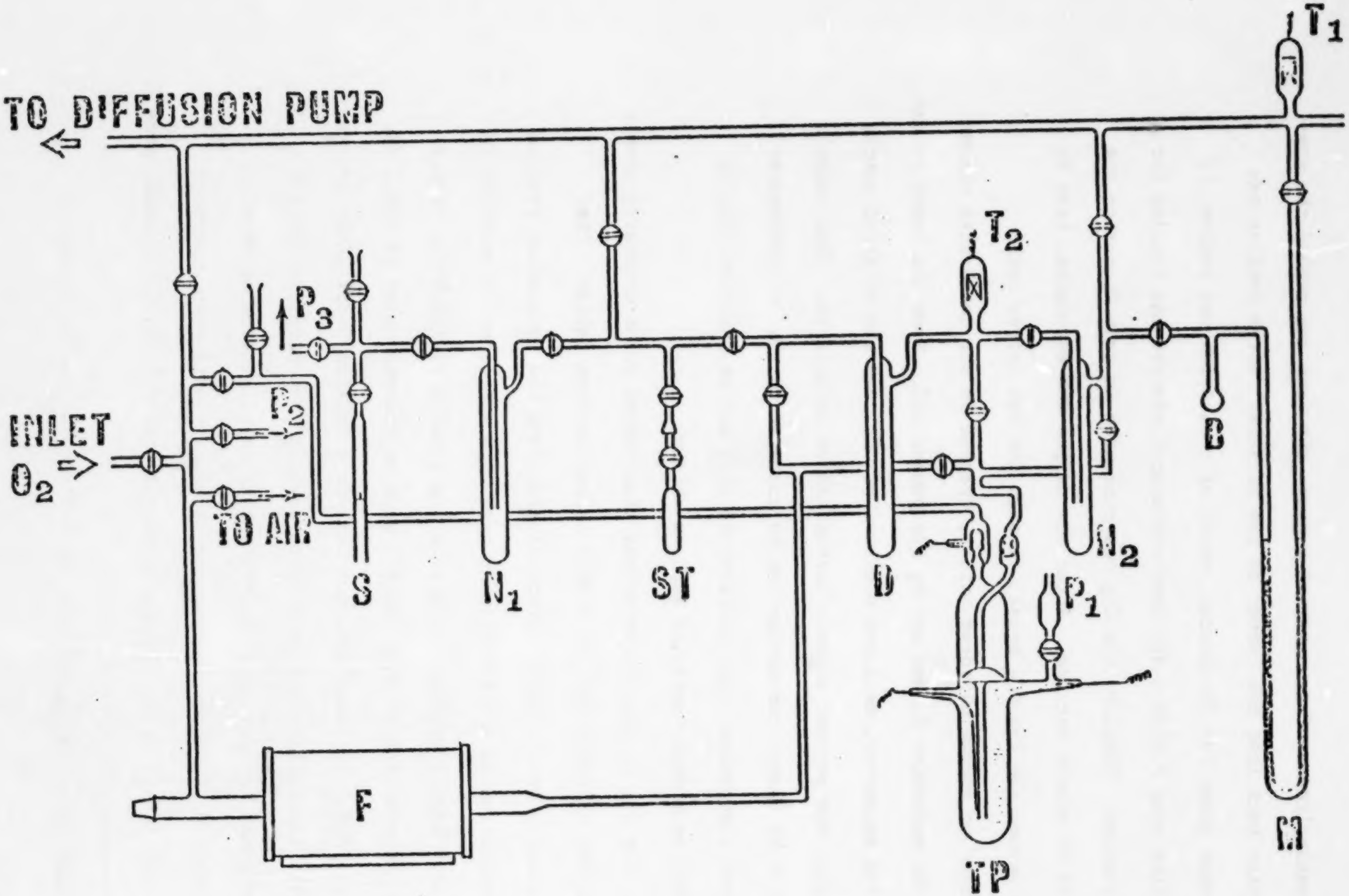
TO DIFFUSION PUMP
T_1
T_2
P_3
P_2
INLET O_2
TO AIR
S
N_1
ST
D
N_2
B
P_1
F
TP
M

Figure 2.1 Schematic of preparatory system for carbon isotopes.

by manipulation of an external magnet, the iron rod pushed the combustion boat into the center of the furnace. After cycling the product gases for 20 minutes, water of combustion was removed by cooling trap D with a dry ice-isopropanol mixture and cycling for 20 minutes. Finally, the CO_2 was condensed in trap N_2 during the third 20 minute cycling. After the oxygen was evacuated, trap N_2 was warmed and the CO_2 passed through the hot copper metal furnace to remove nitrogen oxides, trapped in the calibrated volume in the manometer M, and any N_2 gas pumped off. From the known volume of the manometer, measured pressure of CO_2, and the original sample weight, the percent organic carbon can be calculated. This organic carbon by direct combustion can be compared to the POC determined by wet combustion. Any differences that may be observed will be highly refractory material such as chitin.

The CO_2 in the manometer was transferred to an evacuated sample bulb for determination of stable carbon isotope ratios. The isotopic composition of carbon dioxide from the combustion process was measured in a Nier-McKinney type mass spectrometer relative to a laboratory graphite standard having a value of -24.8°/₀₀ versus PDB[1] as measured through NBS #21 with an assumed value of -28.2°/₀₀ versus PDB. The mass spectrometer was a Nuclide Corp. sixty degree double collecting instrument with specific modifications in the electronic and gas handling systems to permit the measurement of small differences in isotopic abundances with high reproducibility (±0.05°/₀₀). Including sample preparation, the overall precision was ±0.2 °/₀₀. The reported $\delta^{13}C$ values took into account the corrections due to the ^{17}O contribution to mass 45, the leakage of ball joints in the magnetic valves, the mass 44 tail under the 45 peak and the mass 45 background.

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[1] Belemnitella americana from the Cretaceous Pee Dee formation

2.2.2 Surficial Sediments

2.2.2.a Organic Carbon

On receipt of the frozen samples in the laboratory, each was freeze-dried and homogenized in an organic carbon-free ball mill. Accurately weighed one gram aliquots of each homogenized sample were placed in ceramic or metal boats and treated with dilute hydrochloric acid to eliminate inorganic carbon. The samples were combusted at >800°C and the CO_2 measured manometrically. Percent organic carbon was calculated to 0.1% as follows:

$$\%\text{Organic Carbon} = \frac{\dfrac{\text{ml}_{STP}CO_2}{22.4\text{ml}_{STP}/\text{mm}} \times 12\ \text{mgC/mm}}{\text{Sample Weight in mg}} \times 100$$

2.2.2.b Calcium Carbonate

The determination of calcium carbonate on freeze-dried sediment samples was similar to that outlined for water column calcium carbonate. However, instead of placing a filter in one arm of a sidearm evacuation flask, approximately one gram of finely ground, oven dried sediment was added to the flask. Concentrations are reported as percent $CaCO_3$ of the suspended matter to ±0.1%.

2.2.2.c Clay Mineralogy

For clay mineralogy, each sediment sample was digested in deionized water overnight to insure complete dispersion. The clay fraction (<2μ) was completely separated from the bulk sample by treating with 1 ml of 2.5 M NH_4OH (dispersing agent) prior to centrifuging for 2 minutes at 1000 RPM (Beckman 21C centrifuge with SS3 head). Two oriented clay slides were prepared for each sample by treatment with Mg-glycerate saturation and K-saturation. To minimize any experimental variation for an estimate of relative percentages of individual clay minerals, a 35 μ clay film was prepared on ceramic tiles for X-ray diffraction analyses. For each sample, at least eight separate X-ray diffraction analyses, followed by different treatments and heating, were made in order to identify all major types of clay minerals and to estimate semiquantitatively the relative percentages of each clay mineral in the sample. Identification of the 14 Å chloritevermiculite mixed layers follow the criteria discussed by Huang (1975). The flow diagram of the laboratory analysis is shown in Figure 2.2.

Relative percentages of clay minerals were determined on semiquantitative basis, following the technique of Huang (1975), modified after Biscaye (1965), Caroll (1970), and others. The refinement of the estimate was made through the standardization of the sample preparation, treatment and the X-ray diffraction, the consideration of mass-adsorption coefficient of minerals, and the calibration with known amounts of standard clay samples. The deter-

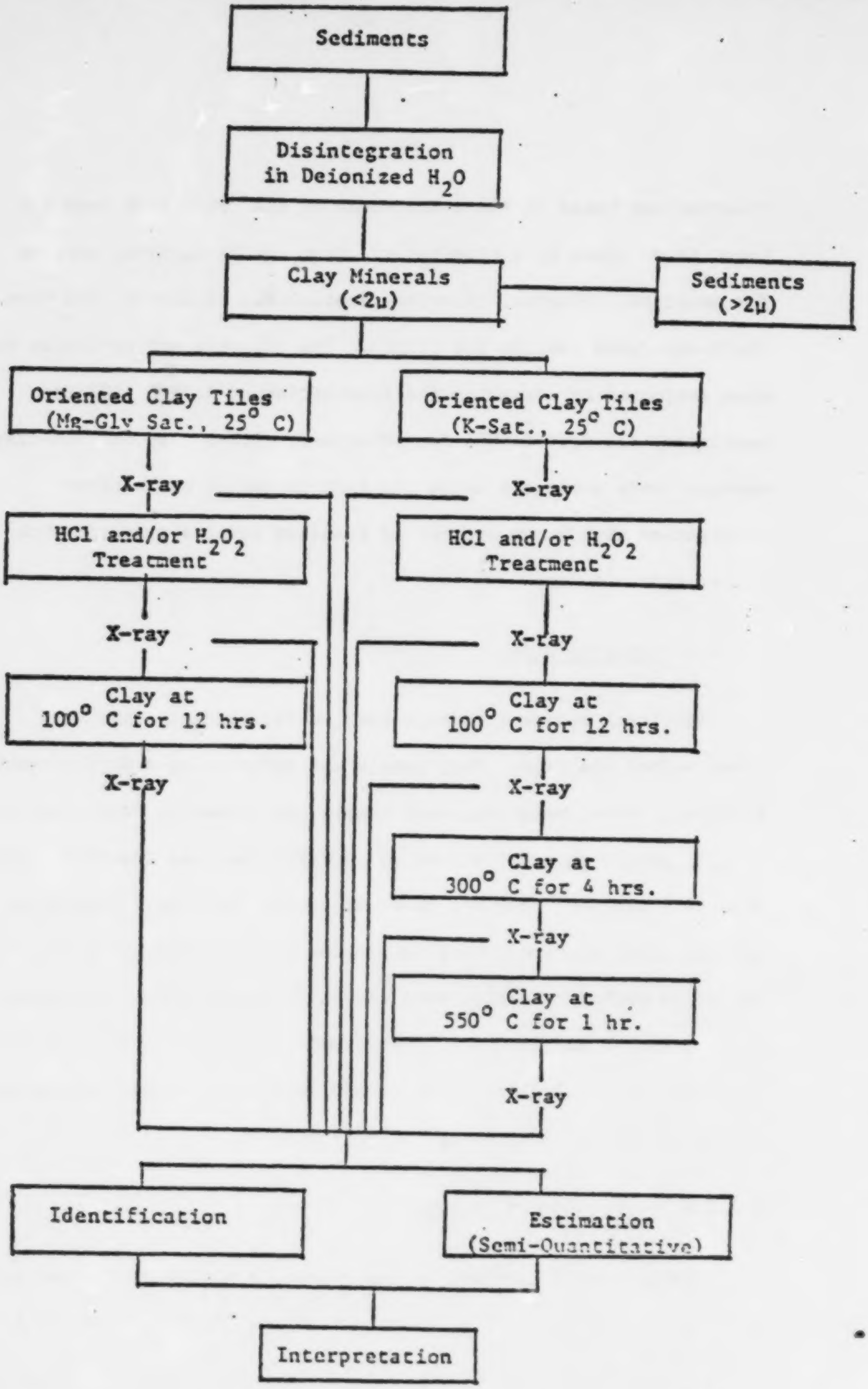
Sediments
Disintegration in Deionized H_2O
Clay Minerals (<2μ)
Sediments (>2μ)
Oriented Clay Tiles (Mg-Gly Sat., 25° C)
Oriented Clay Tiles (K-Sat., 25° C)
X-ray
X-ray
HCl and/or H_2O_2 Treatment
HCl and/or H_2O_2 Treatment
X-ray
X-ray
Clay at 100° C for 12 hrs.
Clay at 100° C for 12 hrs.
X-ray
X-ray
Clay at 300° C for 4 hrs.
X-ray
Clay at 550° C for 1 hr.
X-ray
Identification
Estimation (Semi-Quantitative)
Interpretation

Figure 2.2 Flow diagram for clay mineralogy.

mination was based on the measurement of the (001) peak area (at least three times by a planimeter), from the Mg-glycerol samples for smectite, chlorite, chlorite-vermiculite, kaolinite, and from the K-saturated samples for illite. The chlorite and kaolinite was also estimated by comparing the intensities of 3.58 Å (002 for kaolinite) and 3.54 Å (004 for chlorite). Other clay and non-clay minerals were estimated using the most intensive peaks after calibration with known amounts of standard samples prepared with the same procedures.

2.2.2.d Particle Size

Surficial sediment texture samples for particle size were dried before analysis. Each sample was split using a Riffle sample splitter. After weighing, each sample was soaked in Calgon solution (5 g/l, avg.), then wet sieved to separate the sand fraction (greater than 62.5 microns) from the finer silt-clay fraction. Sand-sized material distribution determination was accomplished using the Ro-Tap and sieve method. Samples were sieved at one-half Phi increments from -1 Phi (2 mm) to 4 Phi (0.0625 mm). The distribution of silt- (4-8 Phi) and clay-sized (less than 8 Phi) material was determined utilizing the settling method of Folk (1974).

2.2.2.e Stable Carbon Isotopes

Stable carbon isotopes on the organic fraction of the sediment were determined on the CO_2 after combustion. Stable carbon isotopes on the calcium carbonate in the sediment were determined on the CO_2 after acidification. Procedures are discussed in Section 2.1.2.k.

2.2.2.f Pb-210 Dating

Radio analyses of one-cm sediment layers for Pb-210 specific activity ($dpm \cdot g^{-1}$) were conducted throughout the upper 20 to 50 cm of cores from six stations. Analytical procedures followed those of Shokes (1976) using low level beta spectroscopy after a strong acid leach of the sedimentary materials and a chromatographic separation of the Pb-210 from interfering isotopes. The combined precision and analytical error on the scale length of these determinations allow measurement of sedimentation rates within $\pm .3$ $mm\ yr^{-1}$ in the past 45 to 50 years.

3. RESULTS AND DISCUSSION

3.1 SUSPENDED PARTICULATES

3.1.1 Total Suspended Particulates - Transmissometry

Total suspended matter distributions in surface and near-bottom waters reflect closely the profiles obtained by transmissometry (Appendix 6.1 contains the transmission records obtained during this study). Lowest TSM concentrations were obtained in surface waters during the summer sampling, averaging around 300 µg/L. During the summer months, the Gulf shelf water is well stratified with a shallow thermocline. The low summer TSM levels result from this seasonal stability which inhibits upward flux of suspended sediment. The productivity of the Gulf surface water is also diminished during this period, due to nutrient depletion in the surface layer. The low summer TSM levels are consequently reflected in low biomass values at the surface during this sampling.

TSM increased dramatically in near-bottom waters during the summer, probably from resuspension of sediments by bottom currents. This near-bottom nepheloid layer was very sharp and located within 2 to 3 meters of the bottom. A much smaller mid-depth nepheloid layer was also observed at many of the summer stations. This mid-depth layer may be associated with primary productivity.

Near-bottom TSM measurements (Table 3.1.1) were similar during both summer and fall samplings: however, a much broader nepheloid layer was observed in the fall. Fall transmission records indicate that the bottom nepheloid layer extended from the bottom (20 m) to a depth of about 10 meters (cf. 2-3 meters in the summer). This feature reflects stronger currents during this sampling period along with decreased stability of the water column, both of which would produce increased turbulent mixing. A small surface TSM maximum was observed at many of the fall stations.

Highest surface TSM concentrations and lowest transmission levels were recorded during the winter sampling. The Gulf shelf water usually overturns and thoroughly mixes after the first winter (or fall) storm lowers surface temperatures and provides sufficient wind energy to drive the mixing process. During December, deeper shelf Gulf water can have a mixed layer depth of 80-100 meters (Wiesenburg and Schink, 1978). Our data indicate that the water column in the Buccaneer field was well mixed during the winter sampling. The TSM data reflects the water column structure during this sampling. There was little to no structure in transmission records. Temperature profiles (not shown) also show a uniform surface-to-bottom structure. Nearly uniform surface and near-bottom TSM levels were observed. No significant near-bottom nepheloid layer existed during this season. The water column was homogenous and the TSM data showed

Table 3.1.1

SUMMARY OF TOTAL SUSPENDED PARTICULATE DISTRIBUTIONS[1]

Season	Platform A		Platform B	
	Surface	Bottom	Surface	Bottom
Summer	321 ± 159	1266 ± 1006	288 ± 138	530 ± 366
Fall	781 ± 281	1015 ± 394	388 ± 119	661 ± 231
Winter	929 ± 267	865 ± 131	1008 ± 221	1075 ± 239
Spring	874 ± 310	1790 ± 738	814 ± 187	1554 ± 260

[1] Each number represents mean or standard deviation of 13 stations near each platform. Concentrations in μg/L.

no other discernable trends.

The transmission records during the spring were more complex. Three distinct nepheloid layers were observed in each profile. A surface layer, containing approximately 800 μg/L of TSM, existed in the upper 5 meters of the water column. Transmission levels increased from approximately 40% to 75% in the 5 to 8 meter depth interval indicating decreased turbidity. A small but distinct mid-depth nepheloid layer was found around 12 meters. A bottom nepheloid layer was observed in the bottom 2 to 3 meters. The highest TSM levels (~1600 μg/L) observed during this study were at near-bottom depths during the spring.

The spring TSM distributions reflect a complex interaction of processes. The shelf water is changing from a vertically mixed system to a characteristic seasonal thermocline situation. The mid-depth nepheloid layer is probably associated with the onset of this seasonal thermocline, since sinking particles tend to congregate at density interfaces. The dramatic bottom nepheloid layer is characteristic of this area in all seasons, except winter when it is less pronounced. There is little difference in TSM composition in bottom water between fall and spring sampling (Figures 3.1.2 and 3.1.4). Also, there is no exceptional increase in organic TSM in the spring, which rules out a productivity factor causing the high TSM at the bottom. We must conclude that the bottom nepheloid layer in the spring, as in the fall, results from increased bottom turbulent mixing due to bottom currents.

In general, the TSM distributions observed at the Buccaneer Oil Field stations are typical of the Gulf shelf region. No noticable differences between up current and down current stations were observed, at least no significant differences and none that could be attributed to the presence of the production platforms. One noticable effect is the higher concentrations of organic TSM in the area which probably result from the "reef effect" of the platforms in enhancing the general productivity of the area.

3.1.2 Organic Carbon

Dissolved organic carbon (DOC) concentrations in surface and near-bottom samples showed little vertical or horizontal variations (Table 3.1.2). DOC concentrations, throughout the year, averaged 1.2 ± 0.2 mgC/L. Winter values, however, were observed to be significantly higher than in other seasons. Winter levels were associated with higher particulate, chlorophyll, and ATP levels. High DOC levels in the winter result from either one of two processes: resuspension of bottom sediments containing high interstitial DOC concentrations, or excretion of dissolved organics by cells associated with the much higher productivity during this period. The latter process is the most probable since this is the one season when the phytoplankton contribution to the TSM is significant (almost 50 percent). The phytoplankton were also distributed similarly to the DOC

Table 3.1.2

SUMMARY OF DISSOLVED AND PARTICULATE ORGANIC CARBON CONCENTRATIONS[1]

Season	Platform A		Platform B	
	Surface	Bottom	Surface	Bottom
	Dissolved Organic Carbon[2]			
Summer	1.33 ± 0.24	1.23 ± 0.16	1.38 ± 0.11	1.34 ± 0.14
Fall	1.20 ± 0.17	1.14 ± 0.20	1.14 ± 0.11	1.15 ± 0.08
Winter	1.71 ± 0.09	1.84 ± 0.19	1.80 ± 0.31	1.82 ± 0.23
Spring	1.15 ± 0.12	0.97 ± 0.10	1.30 ± 0.16	1.01 ± 0.09
	Particulate Organic Carbon[3]			
Summer	65 ± 8	86 ± 21	63 ± 14	75 ± 9
Fall	66 ± 8	72 ± 11	65 ± 10	67 ± 11
Winter	187 ± 17	191 ± 11	156 ± 32	161 ± 25
Spring	166 ± 42	106 ± 44	150 ± 24	96 ± 11

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[1] Each number represents mean or standard deviation of 13 stations near each platform.

[2] Concentrations in mgC/L.

[3] Concentrations in μgC/L.

on a vertical basis. At platform 288-A, the bottom DOC was 8% higher than the surface while the phytoplankton proportion of the TSM increased from 41 percent at the surface to 49 percent at the bottom. This relationship may be fortuitous, but there does seem to be an obvious correlation with higher phytoplankton productivity and higher DOC levels in the winter.

Particulate organic carbon (POC) levels show significant seasonal changes. Summer and fall POC concentrations ranged from 60 to 90 μgC/L with only slight vertical gradation. This observation is in direct contrast to the high TSM levels in bottom waters during these seasons. The relatively uniform POC distributions compared to the variable TSM levels indicate that the high TSM levels in near-bottom waters result from resuspension of bottom sediments containing smaller percentages of organic matter than surface TSM. Thus the bottom nepheloid layers (discussed in the previous section) are confirmed not to be of organic origin.

During the winter, high POC values (Table 3.1.2) are associated with an unstable water column, high TSM and increased biological activity. There is little vertical gradation in POC, except in the spring. Spring POC concentrations averaged 50 percent higher in surface than near-bottom water. These high levels also reflect the large surface TSM layer observed during this period, a result of fresh water runoff (see previous section). In general, POC levels also appeared typical of this region of the Gulf continental shelf.

3.1.3 Biological Indicators

Table 3.1.3 presents average surface and near-bottom chlorophyll a, ATP, and $CaCO_3$ concentrations during the seasonal samplings at stations near platforms A and B. Tables 3.1.4 and 3.1.5 show the particulate organic composition at these platforms. Since carbon constitutes from 40 to 50 percent by weight of most marine organic materials, we used (for purposes of our calculations) a factor of 2.25 for conversion of particulate carbon into particulate organic matter (POM). For conversion of chlorophyll a and ATP into organic carbon, Holm-Hansen and Paerl (1972) among others have used factors of 100 and 250, respectively. Although these multipliers may vary somewhat under different environmental conditions, they are useful in examining the composition of the suspended particulates. We have used them to calculate POM values from the biological data. Chlorophyll a is used to estimate that fraction of the organic carbon which derives from the primary producers. ATP is an estimate of the living cellular material present, whether from phytoplankton, zooplankton and/or bacteria. These parameters were used to determine the suspended particulate compositions. The equations used for the calculations are given below:

$$\text{POM} = \text{POC} \times 2.25 \qquad (1)$$

Table 3.1.3

SUMMARY OF BIOLOGICAL PARAMETERS[1]

Season	Platform A		Platfrom B	
	Surface	Bottom	Surface	Bottom
		Chlorophyll a[2]		
Summer	0.068 ± 0.022	0.195 ± 0.189	0.059 ± 0.016	0.125 ± 0.038
Fall	0.114 ± 0.028	0.129 ± 0.026	0.097 ± 0.026	0.119 ± 0.022
Winter	1.729 ± 0.208	1.872 ± 0.307	1.883 ± 0.469	1.883 ± 0.469
Spring	0.491 ± 0.214	0.557 ± 0.068	0.389 ± 0.152	0.499 ± 0.131
		Adenosine Triphosphate[3]		
Summer	349 ± 201	493 ± 239	552 ± 336	806 ± 368
Fall	288 ± 126	339 ± 154	302 ± 151	301 ± 122
Winter	644 ± 212	791 ± 263	749 ± 196	793 ± 194
Spring	537 ± 155	553 ± 238	532 ± 363	380 ± 224
		Calcium Carbonate[4]		
Fall	1.54 ± 1.25	1.89 ± 2.36	1.68 ± 1.13	2.58 ± 2.73

[1] Each number represents mean or standard deviation of 13 stations near each platform.

[2] Concentrations in mg/m^3.

[3] Concentrations in ng/L.

[4] Concentrations in ug/L.

Table 3.1.4

PARTICULATE ORGANIC COMPOSITION AT PLATFORM A[1]

Season	Depth	TSM[2] (μg/L)	POM[3] (μg/L)	Biomass[3,4] (μg/L)	Phytoplankton[3,5] (μg/L)
Summer	SFC	321	146	196	14
	BT	1266	194	277	43
Fall	SFC	781	148	162	25
	BT	1015	162	189	27
Winter	SFC	929	420	373	387
	BT	865	429	445	420
Spring	SFC	874	373	301	110
	BT	1790	238	310	126

[1] Compositions represent averages of 13 stations near Platform A.

[2] See Table 3.1.1.

[3] Carbon concentrations (Table 3.1.2.) multiplied by 2.25 to convert to particulate organic matter.

[4] ATP concentrations (Table 3.1.3.) times 250 to convert to biomass C.

[5] Chlorophyll concentrations (Table 3.1.3.) times 100 to convert to phytoplankton C.

$$\text{Biomass} = (\text{ATP} \times 250) \times 2.25 \qquad (2)$$

$$\text{Phyto.} = (\text{Chl } \underline{a} \times 100) \times 2.25 \qquad (3)$$

These equations were used to convert all data from organic carbon concentrations to POM data so the POM component of the TSM could be deciphered. Figures 3.1.1 through 3.1.4 are pie diagrams which depict the percentage distributions of constituents making up the TSM. Cellular material is equivalent to total biomass (equation 2), while non-cellular material is the difference between POM and biomass, if any. The phytoplankton constituent of the TSM is part of the overall biomass data, but can be estimated separately by measuring chlorophyll.

Tables 3.1.4 and 3.1.5 indicate that very little particulate organic matter is non-cellular material. In most cases, cellular biomass (determined by ATP concentrations) is greater than particulate organic matter determined by POC. An exception, however, is surface water during the spring when as much as 25 % of the POC was non-cellular organics. This is consistent with the surface nepheloid layer which is characterized by high TSM and POC levels during this period. The high levels of non-cellular organics in this layer probably reflects a fresh water inflow from Galveston Bay. Such an inflow would input land plant debris as non-cellular, non-living POC. There also were measurable concentrations of non-cellular organics during the winter cruise, in surface waters at platform A, but not B. This could represent excretion of cellular material from the large winter

Table 3.1.5

PARTICULATE ORGANIC COMPOSITION AT PLATFORM B[1]

Season	Depth	TSM[2] (μg/L)	POM[3] (μg/L)	Biomass[3,4] (μg/L)	Phytoplankton[3,5] (μg/L)
Summer	SFC	288	141	310	14
	BT	530	168	454	27
Fall	SFC	338	146	171	23
	BT	661	150	169	27
Winter	SFC	1008	351	421	423
	BT	1075	362	445	423
Spring	SFC	814	337	299	90
	BT	1554	216	214	113

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[1] Compositions represent averages of 13 stations near Platform B.

[2] See Table 3.1.1.

[3] Carbon concentrations (Table 3.1.2.) multiplied by 2.25 to convert to particulate organic matter.

[4] ATP concentrations (Table 3.1.3.) times 250 to convert to biomass C.

[5] Chlorophyll concentrations (Table 3.1.3.) times 100 to convert to phytoplankton C.

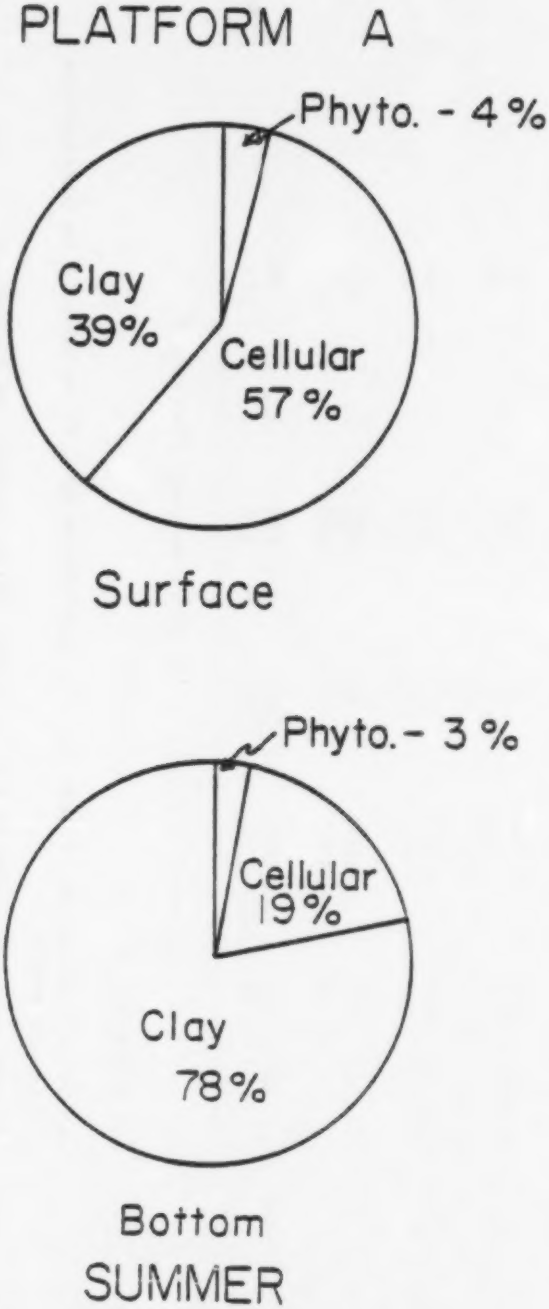

Figure 3.1.1. Composition of suspended particulates at 13 stations near Platform A during the Summer sampling. Phyto. = phytoplankton biomass estimated from chlorophyll a. Cellular = cellular biomass estimated from ATP minus phytoplankton biomass.

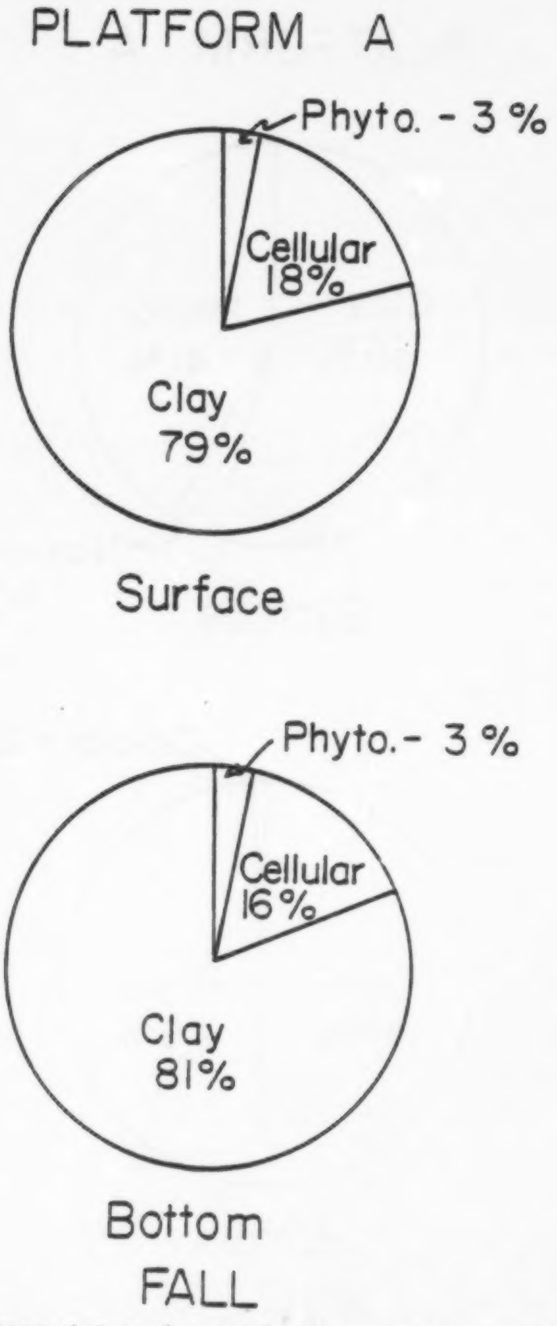

Figure 3.1.2. Composition of suspended particulates at 13 stations near Platform A during the Fall sampling. Phyto. = phytoplankton biomass estimated from chlorophyll a. Cellular = cellular biomass estimated from ATP minus phytoplankton biomass.

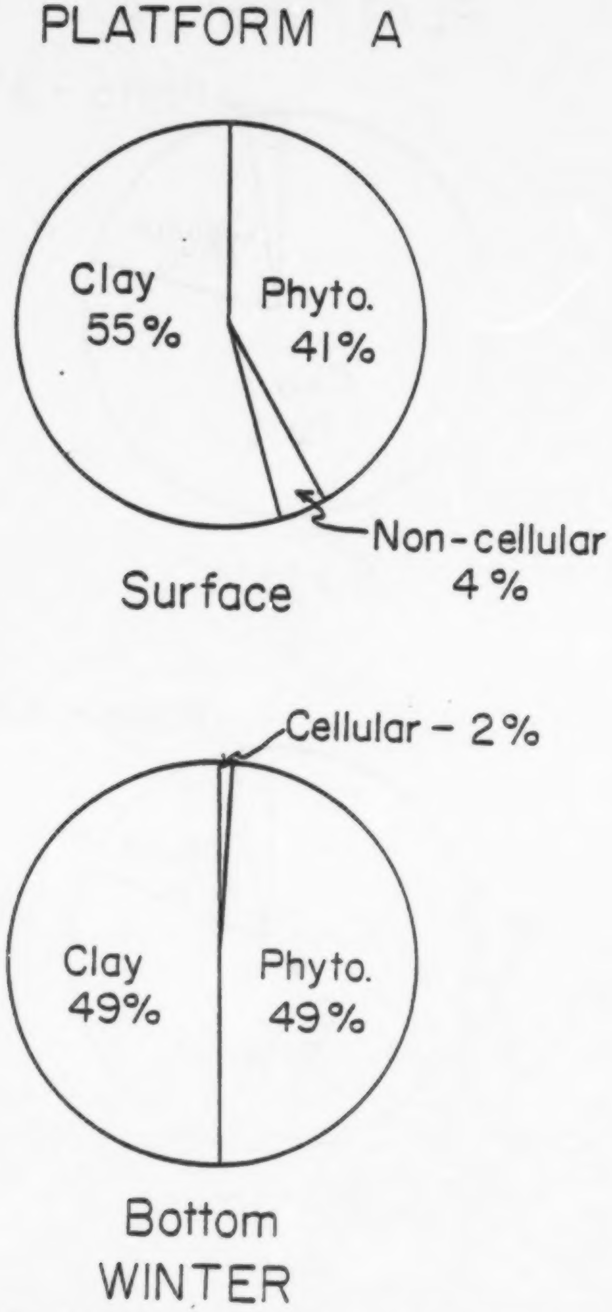

Figure 3.1.3. Composition of suspended particulates at 13 stations near Platform A during the Winter sampling. Phyto. = phytoplankton biomass estimated from chlorophyll a. Cellular = cellular biomass estimated from ATP minus phytoplankton biomass.

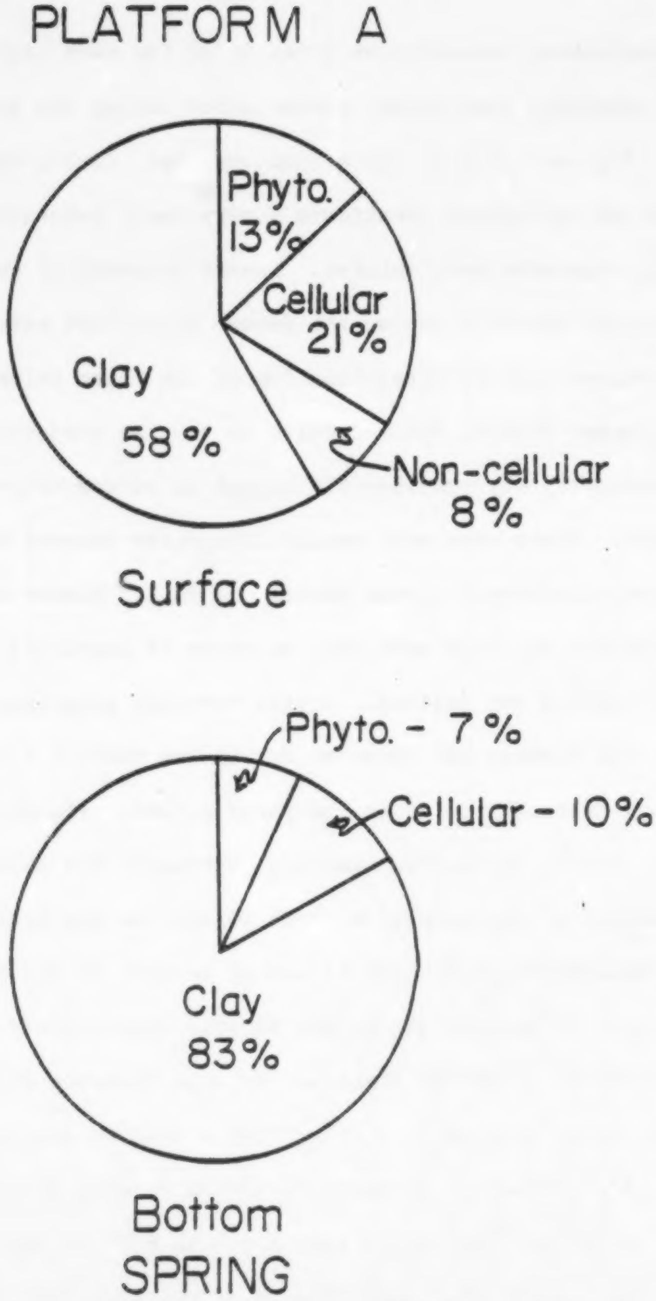

Figure 3.1.4. Composition of suspended particulates at 13 stations near Platform A during the Spring sampling. Phyto. = phytoplankton biomass estimated from chlorophyll a. Cellular = cellular biomass estimated from ATP minus phytoplankton biomass.

phytoplankton community as a result of the very high productivity and resulting inefficient assimilation during the winter.

Figures 3.1.1 to 3.1.4 indicate that, during the summer and fall, phytoplankton constitute a very small percentage of the total suspended particulates. Lowest chlorophyll concentrations were also observed during the summer in surface waters. These low values reflect stratification of the water column during the summer months, which results in the low productivity observed. Productivity was considerable higher in bottom waters during the summer. There were only small differences between surface and bottom chlorophyll levels during the fall. Winter chlorophyll concentrations were more than an order of magnitude higher than the previous two seasons. Little vertical gradation in phytoplankton biomass was observed during the winter; a result of strong vertical mixing in the water column. Figure 3.1.3 shows that, during the winter sampling, virtually all cellular material consisted of phytoplankton, both in surface and bottom waters. Phytoplankton constituted 41 and 49 percent of the particulate material in surface and bottom waters, respectively, during the winter. Although there was a large standing crop in the water column during the spring, phytoplankton only constituted 13 and 7 percent in surface and bottom waters, respectively. The spring phytoplankton population was high in the spring, but percentages are lower because of the high TSM levels.

ATP concentrations are a measure of total cellular material. Table 3.1.3 shows that, although less pronounced, ATP concentrations show the same general trends as chlorophyll concentrations. This would be expected since bacterial biomass would be indirectly associated with the plankton. The cellular material(ATP-phytoplankton), generally constituted between 20 and 35 percent of the total suspended particulates during the summer, fall and spring. During the winter, in an apparent phytoplankton bloom, cellular material constituted 50 percent of suspended particulates.

Calcium carbonate levels were low during all seasons and represent an insignificant fraction of the TSM. Only during the fall were sufficient volumes of water filtered to determine carbonate concentrations. All $CaCO_3$ concentrations were below 0.4 % of the total suspended particulates. The carbonate observed was probably from organisms which have carbonate exoskeletons. The low values observed are thought to be typical of this region of the Gulf.

There appears to be some obvious spacial variations around platform B. While chlorophyll concentrations were relatively high in winter, chlorophyll a concentrations were almost 50 % lower along the south leg of stations at platform B during the winter. Associated POC and ATP values were also lower along this line of stations. No such trend was observed at platform A during the winter. In summer, this same trend was observed to a lesser extent to the north of the platform. The cause of these directional gradients remains uncertain, although it is possible they are related to sampling patterns.

3.1.4 Nutrients

Nitrate and nitrite concentrations show few patterns during the summer, fall and winter seasons (Table 3.1.6). The concentrations range from 0.23 to 0.44 μM for nitrate and 0.14 to 0.18 μM for nitrite, with relatively uniform distribution in relation to depth, direction or platform. During the spring season, however, there is some variation in both concentration and distribution of these parameters. Nitrate increases in surface waters to an average of 2.7 μM and 1.7 μM for bottom waters around platform A, while platform B has concentrations of 3.0 μM for the surface and 1.6 μM for bottom waters. Nitrite shows a similar pattern of increase, but the differences between the surface and bottom waters are not as distinct. Both parameters appear to be uniformly distributed relative to direction around each of the platforms. Since nitrite is relatively unstable in oxygenated surface waters, the spring pattern probably results from a fresh water inflow into this region.

Phosphate values (Table 3.1.6) are uniform and constant at 0.27 to 0.40 μM for all stations throughout the year except during the fall. The concentrations for this season are 0.47 to 0.63 μM with values at Platform B tending to be higher than at Platform A.

Table 3.1.6

SUMMARY OF NUTRIENTS CONCENTRATIONS[1]

Season	Platform A		Platform B	
	Surface	Bottom	Surface	Bottom
		Phosphate[2]		
Summer	0.31 ± 0.03	0.32 ± 0.05	0.29 ± 0.12	0.32 ± 0.10
Fall	0.52 ± 0.05	0.55 ± 0.05	0.59 ± 0.06	0.55 ± 0.42
Winter	0.39 ± 0.02	0.40 ± 0.02	0.39 ± 0.02	0.38 ± 0.02
Spring	0.30 ± 0.05	0.36 ± 0.04	0.38 ± 0.04	0.39 ± 0.04
		Nitrate[2]		
Summer	0.31 ± 0.05	0.31 ± 0.05	0.23 ± 0.03	0.25 ± 0.02
Fall	0.38 ± 0.06	0.40 ± 0.09	0.36 ± 0.11	0.34 ± 0.04
Winter	0.34 ± 0.03	0.34 ± 0.03	0.32 ± 0.03	0.32 ± 0.03
Spring	2.73 ± 0.32	1.74 ± 0.05	3.03 ± 0.85	1.59 ± 0.20
		Silicate[2]		
Summer	2.53 ± 0.07	3.26 ± 0.52	2.00 ± 0.31	2.58 ± 0.41
Fall	5.23 ± 0.20	5.35 ± 0.16	5.04 ± 0.32	4.94 ± 0.55
Winter	1.25 ± 0.05	1.25 ± 0.05	1.15 ± 0.05	1.15 ± 0.05
Spring	4.75 ± 2.54	13.06 ± 0.35	4.57 ± 0.45	11.99 ± 2.98

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[1] Each number represents mean or standard deviation of 13 stations near each platform.

[2] Concentrations in μM.

Almost all the silicate present is in the dissolved form (Appendix 6.2). The concentrations show no distinct relationship to platform or direction, but concentrations in bottom samples are higher than surface values. This trend is especially evident during the spring when bottom values (12.5 to 13.5 μM) are three times the surface values (4.1 to 4.5 μM).

The general nutrient profiles from the Buccaneer field are typical for this area. There are no disernible relationship to either the platform or direction from the platform. The surface-to-bottom variations that were observed probably result from inflow at the surface and nutrient transport or regeneration in the bottom waters.

3.1.5 Carbon Isotopes

The carbon isotope determinations on particulate organic carbon are presented in Appendix 6.2. Values are typical of normal oceanic carbon isotope compositions. There is little isotope evidence for major terrestrial contributions or organic contamination from the platforms which would result in isotopically light (more negative) carbon. The $\delta^{13}C$ values are significantly more negative in bottom samples at Platform A during the fall than other seasons. This corresponds to the large near-bottom nepheloid layer during this season. The lighter values may result from a more terrestrial POC component from the resuspended bottom sediments.

3.1.6 Clay Mineralogy

Tables 3.1.7 through 3.1.10 present the clay mineralogy data from Buccaneer Field. The percent of smectite is generally much higher in the suspended sediments in the summer. The winter samples show very little smectite in the suspended sediments. The percent of illite in the suspended sediments is much lower than that of the sediments in the summer and slightly higher than that of the sediments in the winter. During the summer, the percentage of kaolinite in the suspended sediments is less or about equal to that in the bottom sediments. The percent of kaolinite is lower than smectite and illite during fall, spring, and summer and higher than smectite during the winter. The winter samples contain slightly less illite than kaolinite.

The percent of smectite in the suspended sediments is higher in the top of the water columns during the fall and summer. During the spring, the smectite appears to be concentrated toward the bottom of the column. The percent of illite is higher towards the top of the water column in the spring. The summer and fall samples show very little illite in the suspended sediments. In the winter, the illite appears to be evenly distributed throughout the water column and of much higher concentration than in the summer and fall. During the fall and the spring, the percent of kaolinite is generally higher towards the bottom of the column. The percent of kaolinite is highest in the winter and lowest in the summer

Table 3.1.7

CLAY MINERALOGY IN WATER COLUMN, SUMMER, 1978

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]	Quartz[1]
288	AN 2/S	50	--	25	25
288	AN 2/B	--	--	--	100
288	AS 2/S	100	--	--	--
288	AS 2/B	--	20	19	61
288	AE 2/S	100	--	--	--
288	AE 2/B	27	20	15	39
288	AW 2/S	100	--	--	--
288	AW 2/B	100	--	--	--
288	AN 2/B (2)	100	--	--	TR
296	BN 2/S	6	19	14	61
296	BN 2/B	50	--	--	50
296	BS 2/S	72	--	28	--
296	BS 2/B	76	--	24	--
296	BE 2/S	100	--	--	--
296	BE 2/B	--	TR	--	100
296	BW 2/S	100	--	--	--
296	BW 2/B	66	18	--	16

[1] Values are percent of total clay.

Table 3.1.8

CLAY MINERALOGY IN WATER COLUMN, FALL, 1978

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]	Quartz[1]
288	AN 2/S	20	8	43	29
288	AN 2/B	10	13	30	47
288	AS 2/S	--	--	--	100
288	AS 2/B	--	--	32	68
288	AE 2/S*	NA	NA	NA	NA
288	AE 2/B	74	--	8	18
288	AW 2/S	63	--	--	37
288	AW 2/B	35	14	11	40
296	BN 2/S	47	--	--	53
296	BN 2/B	27	13	16	44
296	BN 2/S* (2)	NA	NA	NA	NA
296	BS 2/S	48	--	--	52
296	BS 2/B	50	7	--	43
296	BE 2/B	8	--	--	92
296	BW 2/S	77	--	--	23
296	BW 2/B	39	19	--	42

* No data available

[1] Values are percent of total clay.

Table 3.1.9

CLAY MINERALOGY IN WATER COLUMN, WINTER, 1978

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]	Quartz[1]
288	AN 2/S	TR	39	46	15
288	AN 2/B	--	33	43	24
288	AS 2/S*	NA	NA	NA	NA
288	AS 2/B	20	55	--	25
288	AE 2/S	--	38	42	20
288	AE 2/B	TR	23	59	18
288	AW 2/S	--	40	60	--
288	AW 2/B	TR	40	46	14
288	AE 2/S (2)	TR	50	18	32
296	BN 2/S	19	31	14	36
296	BN 2/B	TR	44	36	20
296	BS 2/S	--	47	34	19
296	BS 2/B	--	38	43	19
296	BE 2/S*	NA	NA	NA	NA
296	BE 2/B	TR	37	40	23
296	BW 2/S	9	24	40	27
296	BW 2/B	TR	41	49	10

* No data available

[1] Values are percent of total clay.

Table 3.1.10

CLAY MINERALOGY IN WATER COLUMN, SPRING, 1979

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]	Quartz[1]
288	AN 2/S	--	100	--	--
288	AN 2/B	41	19	13	27
288	AS 2/S	--	100	--	--
288	AS 2/B	42	21	11	26
288	AE 2/S	--	89	--	11
288	AE 2/B	21	21	15	43
288	AW 2/S	--	100	--	--
288	AW 2/B	35	22	16	27
296	BN 2/S	--	90	--	10
296	BN 2/B	35	17	13	35
296	BS 2/S	--	82	--	18
296	BS 2/B	33	18	24	25
296	BE 2/S	--	75	--	25
296	BE 2/B	32	16	15	37
296	BW 2/S	--	75	--	25
296	BW 2/B	24	37	12	27

[1] Values are percent of total clay.

and is generally greater towards the bottom of the water column.

The summer samples are the highest in smectite. The winter samples are highest in both illite and kaolinite and lowest in smectite concentration. The spring samples show the illite concentration to be the highest of all. In all the samples, the quartz concentration remains fairly constant to slightly higher towards the bottom of the water column with the highest concentration being in the fall.

3.1.7 Particle Size

Water column samples have been analyzed for inorganic particulate material in the size range 1 to 11 phi (500 microns to 0.45 microns). This was accomplished by filtering the entire water sample through a 0.45 micron Metricel membrane filter and examining the filter microscopically using a superimposed 5 x 5 micron grid. Particles were measured on a Vidio screen using the imposed grid as a reference area. If less than 75 inorganic particles were present in a particular sample, no statistical analysis was attempted. This was a problem in spring samples, when the maximum number of grains present did not exceed nine (9) within the grain size range examined. Suspended particulate data for the fall, winter and spring samplings are presented in Tables 3.1.11 to 3.1.16.

Table 3.1.11

SUSPENDED PARTICULATES, FALL DATA, 1978

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	BN4S	N.25M.	9.20	8.98	0.73	-0.36	0.61
296	BN2B(A)	N.25M.	7.95	7.75	0.79	-0.41	0.98
296	BN2B(B)	N.25M.	9.25	9.15	0.65	-0.29	0.93
296	BN3S	N.50M.	8.70	8.50	1.05	-0.24	0.77
296	BN3B	N.50M.	8.30	8.07	1.54	-0.12	1.24
296	BN4S	N.100M.	8.50	8.60	0.87	0.01	0.97
296	BN4B(A)	N.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BN4B(B)	N.100M.	8.80	8.80	0.89	-0.12	0.78
296	BS2S	S.25M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BS2B	S.25M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BS3S	S.50M.	9.10	8.97	0.74	-0.27	0.66
296	BS3B	S.50M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BS4S(B)	S.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BS4S(A)	S.100M.	8.40	8.65	0.88	0.21	0.83
296	BS4B	S.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BE2S	E.25M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BE2B	E.25M.	INSUFFICINET PARTICLES FOR ANALYSIS				
296	BE3S	E.50M.	8.95	8.88	0.86	-0.23	0.85
296	BE3B(B)	E.50M.	INSUFFICINET PARTICLES FOR ANALYSIS				
296	BE3B(A)	E.50M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BE4S	E.100M.	8.60	8.58	0.84	0.27	0.97
296	BE4B	E.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BW2S	W.25M.	8.95	8.82	0.86	-0.32	0.82
296	BW2B	W.25M.	8.30	8.23	0.98	-0.08	0.94
296	BW3S	W.50M.	9.05	8.95	0.80	-0.27	0.99
296	BW3B	W.50M.	9.35	9.17	0.66	-0.44	0.96
296	BW4S	W.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BW4B	W.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296F	Sat. Jacket		9.00	8.95	0.66	-0.12	0.67

Table 3.1.11 cont'd.

SUSPENDED PARTICULATES, FALL DATA, 1978

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
288	AN2S	N.25M.	8.70	8.58	0.98	-0.25	0.94
288	AN2B	N.25M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
288	AN3S	N.50M.	9.50	9.17	0.76	-0.66	0.87
288	AN3B	N.50M.	8.75	8.67	0.98	-0.28	1.03
288	AS2S	S.25M.	9.55	9-27	0.73	-0.64	1.12
288	AS2B	S.25M.	8.65	8.67	0.85	-0.06	0.96
288	AS3S	S.50M.	8.20	8.13	1.16	-0.14	0.89
288	AS3B	S.50M.	9.30	8.65	1.30	-0.69	0.91
288	AS4S	S.100M.	9.55	9.35	0.55	-0.52	1.13
288	AS4B	S.100M.	9.60	9.27	0.69	-0.64	0.99
288	AE2S	E.25M.	8.70	8.60	0.94	-0.24	1.15
288	AE2B	E.25M.	9.00	8.90	0.88	-0.29	1.12
288	AE3S	E.50M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
288	AE3B	E.50M.	9.40	9.12	0.85	-0.59	1.19
288	AE4S	E.100M.	9.10	9.00	0.72	-0.25	0.86
288	AE4B	E.100M.	9.40	9.25	0.61	-0.44	1.17
288	AW2S	W.25M.	9.50	9.15	0.87	-0.67	1.14
288	AW2B	W.25M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
288	AW3S	W.50M.	8.35	8.35	0.88	-0.03	0.94
288	AW3B	W.50M.	9.60	9.25	0.76	-0.66	0.87
288	AW4S	W.100M.	9.20	9.00	0.78	-0.41	0.85
288	AW4B	W.100M.	INSUFFICIENT PARTICLES FOR ANALYSIS				

Table 3.1.12

SUSPENDED PARTICULATES, WINTER DATA, 1979

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
288	AN2S	N.25.M.	8.40	8.62	0.76	0.27	0.89
288	AN2B	N.25.M.	8.30	8.45	0.69	0.16	1.14
288	AN3S	N.50.M.	8.25	8.30	0.68	0.08	1.42
288	AN3S-Dup.	N.50.M.	8.40	8.28	1.36	-0.22	0.97
288	AN3B	N.50.M.	8.50	8.55	0.77	0.00	1.38
288	AN4S	N.100.M.	9.10	8.97	0.70	-0.25	0.71
288	AN4B	N.100.M.	8.35	8.52	0.90	0.15	0.88
288	AS2S	S.25.M.	9.00	8.97	0.64	-0.12	0.73
288	AS2B	S.25.M.	8.80	8.77	0.79	-0.11	0.79
288	AS3S	S.50.M.	8.50	8.60	0.85	0.02	1.09
288	AS3B	S.50.M.	9.50	9.12	0.88	-0.69	0.95
288	AS4S	S.100.M.	9.00	8.92	0.71	-0.19	0.70
288	AS4B	S.100.M.	8.80	8.78	0.81	-0.13	0.76
288	AE2S	E.25.M.	8.50	8.60	0.82	0.05	1.07
288	AE2B	E.25.M.	9.20	8.98	0.75	-0.28	0.98
288	AE3S	E.50.M.	8.45	8.48	1.03	-0.14	1.35
288	AE3B	E.50.M.	8.65	8.58	0.61	-0.13	0.92
288	AE4S	E.100.M.	8.70	8.78	0.67	0.14	0.71
288	AE4B	E.100.M.	8.55	8.65	0.83	0.09	0.94
288	AW2S	W.25.M.	8.50	8.53	0.78	0.06	0.80
288	AW2B	W.25.M.	8.70	8.82	0.67	0.17	0.71
288	AW3S	W.50.M.	8.30	8.42	0.73	0.21	1.48
288	AW3B	W.50.M.	8.40	8.55	0.84	0.11	1.02
288	AW4S	W.100.M.	8.45	8.58	0.79	0.10	1.01
288	AW4B	W.100.M.	8.40	8.60	0.73	0.27	0.92

Table 3.1.12 cont'd.

SUSPENDED PARTICULATES, WINTER DATA, 1979

Station	Sample No.	Location	Median Grain (Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	BN2S	N.25.M.	9.20	9.10	0.71	-0.32	0.00
296	BN2B	N.25.M.	9.30	9.27	0.60	-0.32	1.71
296	BN3S	N.50.M.	9.00	8.87	0.73	-0.26	0.69
296	BN3B	N.50.M.	8.55	8.57	0.90	-0.12	1.33
296	BN4S	N.100.M.	8.65	8.72	0.74	-0.02	1.16
296	BN4B	N.100.M.	9.55	9.23	0.78	-0.63	1.25
296	BS2S	S.25.M.	INSUFFICIENT PARTICLES FOR ANALYSIS				
296	BS2B	S.25.M.	9.70	9.28	0.98	-0.74	1.94
296	BS3S	S.50.M.	8.45	8.48	0.98	-0.12	1.30
296	BS3B	S.50.M.	8.65	8.62	0.91	-0.12	0.90
296	BS4S	S.100.M.	9.15	9.00	0.72	-0.25	0.67
296	BS4B	S.100.M.	8.10	8.22	0.77	-0.12	1.37
296	BE2S	E.25.M.	9.30	9.07	0.76	-0.50	1.00
296	BE2B	E.25.M.	8.30	8.15	0.78	-0.29	1.13
296	BE3S	E.50.M.	9.60	9.18	0.97	-0.73	1.51
296	BE3B	E.50.M.	8.80	8.80	0.86	-0.13	0.87
296	BE4S	E.100.M.	9.60	9.40	0.61	-0.61	1.50
296	BE4B	E.100.M.	8.70	8.48	1.12	-0.25	0.66
296	BE4B-Dup.	E.100.M.	8.65	8.73	0.68	-0.11	0.82
296	BW2S	E.25.M.	8.60	8.62	0.85	-0.07	1.08
296	BW2B	W.25.M.	9.00	8.77	1.01	-0.40	0.87
296	BW3S	W.50.M.	9.60	9.32	0.60	-0.63	1.04
296	BW3B	W.50.M.	9.65	9.45	0.60	-0.59	2.20
296	BW4S	W.100.M.	8.15	8.22	1.07	-0.02	2.11
296	BW4B	W.100.M.	8.05	7.93	0.86	-0.04	0.97
296	296 F-S	Flare Stack	9.0	8.98	0.65	-0.10	0.76
296	296 F-B	Flare Stack	9.0	8.87	0.77	-0.24	0.80
296	296 F-S-Dup.	Flare Stack	9.10	8.98	0.71	-0.23	0.66
296	296 F-B-Dup.	Flare Stack	9.45	9.12	0.84	-0.61	1.13

Table 3.1.13

SUSPENDED PARTICULATES, SPRING DATA, 1979

Station	Sample No.	Location	Median Grain Size (0)	Mean Grain Size (0)	St. Dev. (0)	Skewness	Kurtosis
288	AN2S	N.25M.	9.18	8.99	0.76	-0.18	0.86
288	AN2B	N.25M.	9.05	8.92	0.69	-0.13	0.78
288	AN3S	N.50M	9.35	9.13	0.69	-0.22	0.86
288	AN3B	N.50M.	8.40	8.52	0.72	0.12	1.01
288	AN4S	N.100M.	9.00	8.90	0.74	-0.10	0.79
288	AN4B	N.100M.	8.30	8.43	0.67	0.17	1.43
288	AE2S	E.25M.	9.50	9.26	0.65	-0.28	1.10
288	AE2B	E.25M.	8.50	8.63	0.71	0.14	1.13
288	AE3S	E.50M.	9.10	8.97	0.71	-0.14	0.94
288	AE3B	E.50M.	8.60	8.67	0.66	0.08	1.13
288	AE4S	E.100M.	9.38	9.19	0.60	-0.23	1.09
288	AE4S-Dup.	E.100M.	9.05	8.97	0.70	-0.09	0.72
288	AE4B	E.100M.	8.79	8.83	0.68	0.04	0.77
288	AE4B-Dup.	E.100M.	8.75	8.82	0.61	0.08	0.89
288	AS2S	S.25M.	9.50	9.23	0.65	-0.60	0.93
288	AS2B	S.25M.	8.90	8.90	0.65	0.00	0.68
288	AS3S	S.50M.	9.30	9.03	0.75	-0.25	0.75
288	AS3B	S.50M.	8.60	8.62	0.63	0.02	0.82
288	AS4S	S.100M.	9.10	8.97	0.74	-0.13	0.71
288	AS4B	S.100M.	8.30	8.42	0.73	0.13	1.18
288	AW2S	W.25M.	9.30	9.15	0.63	-0.17	0.84
288	AW2B	W.25M.	8.30	8.47	0.67	0.19	1.05
288	AW3S	W.50M.	9.10	8.97	0.70	-0.14	0.82
288	AW3B	W.50M.	8.60	8.72	0.72	0.11	0.78
288	AW4S	W.100M.	9.38	9.18	0.61	-0.23	0.78
288	AW4B	W.100M.	9.30	9.17	0.63	-0.17	1.00
288	AWJS	Well Jacket	9.40	9.30	0.40	-0.15	0.59
288	AWJB	Well Jacket	8.60	8.62	0.77	0.02	1.02

Table 3.1.13 cont'd.

SUSPENDED PARTICULATES, SPRING DATA, 1979

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	BN2S	N.25M.	9.05	8.88	0.86	-0.37	1.02
296	BN2S-Dup.	N.25M.	9.05	8.92	0.68	-0.26	0.71
296	BN2B	N.25M.	8.40	8.57	0.72	0.23	1.05
296	BN3S	N.50M.	8.55	8.58	0.81	-0.04	1.05
296	BN3B	N.50M.	8.40	8.55	0.65	0.30	1.05
296	BN4S	N.100M.	9.25	9.08	0.64	-0.36	1.04
296	BN4B	N.100M.	8.40	8.53	0.69	0.17	1.09
296	BE2S	E.25M.	9.00	8.90	0.77	-0.25	0.74
296	BE2B	E.25M.	8.45	8.57	0.74	0.13	1.14
296	BE3S	E.50M.	9.30	9.08	0.71	-0.46	1.35
296	BE3B	E.50M.	8.60	8.67	0.71	0.07	1.01
296	BE4S	E.100M.	9.05	8.97	0.73	-0.26	0.84
296	BE4S-Dup.	E.100M.	9.40	9.18	0.63	-0.45	0.87
296	BE4B	E.100M.	8.30	8.42	0.75	0.12	1.25
296	BS2S	S.25M.	9.00	8.95	0.71	-0.05	0.79
296	BS2B	S.25M.	8.20	8.18	1.10	-0.04	0.87
296	BS2B-Dup.	S.25M.	8.40	8.47	0.93	-0.04	1.14
296	BS3S	S.50M.	9.00	8.97	0.75	-0.17	0.82
296	BS3B	S.50M.	8.30	8.37	0.77	0.04	1.77
296	BS3B-Dup.	S.50M.	8.65	8.75	0.67	0.19	0.80
296	BS4S	S.100M.	9.10	8.98	0.66	-0.28	1.26
296	BS4B	S.100M.	9.00	8.93	0.65	-0.14	0.94
296	BW2S	W.25M.	8.80	8.88	0.68	0.11	0.72
296	BW2B	W.25M.	8.50	8.68	0.69	0.27	0.80
296	BW3S	W.50M.	8.90	8.88	0.70	-0.05	0.70
296	BW3B	W.50M.	8.55	8.75	0.84	0.10	0.98
296	BW3B-Dup.	W.50M.	8.50	8.57	0.77	0.00	1.15
296	BW4S	W.100M.	9.00	8.88	0.87	-0.33	1.00
296	BW4B	W.100M.	8.35	8.47	0.67	0.17	1.37
296	FSBS	Flare Stack	9.40	9.17	0.80	-0.25	1.51
296	FSBB	Flare Stack	8.75	8.82	0.71	0.07	0.72

3.2 SURFICIAL SEDIMENTS

Surficial sediments were collected along transects aligned north, east, south and west of platforms 288A and 296B with sampling stations at 10, 25 and 50 meters from the brine discharge pipe. Well jacket and flare stack samples were also collected. The mean grain size, skewness (measure of sample population symmetry) and kurtosis values (measure of peakedness of the population distribution) were measured seasonally. Percent organic carbon, percent $CaCO_3$ and their respective $\delta^{13}C$ values, and clay mineralogy were determined on the winter and summer samples. Pb-210 distributions were determined from six cores within the field.

3.2.1 Pb-210 Dating

3.2.1.a Surface Pb-210 Distribution

The relatively low, and uniform, surface sediment Pb-210 activity among the six stations (see Figure 3.2.1) indicates a similarly uniform sedimentary composition and origin. The bulk of the materials are terrigenous and are moderately coarse-grained. Although Stations 2 and 3 have slightly higher surface values (Table 3.2.1), the probable cause is an apparently greater degree of mixing in the top one or two cm at Stations 1, 5 and 6 (Figure 3.2.2 and 3.2.3).

3.2.1.b Sedimentation Rates

There is a definite trend in sedimentation rates among the

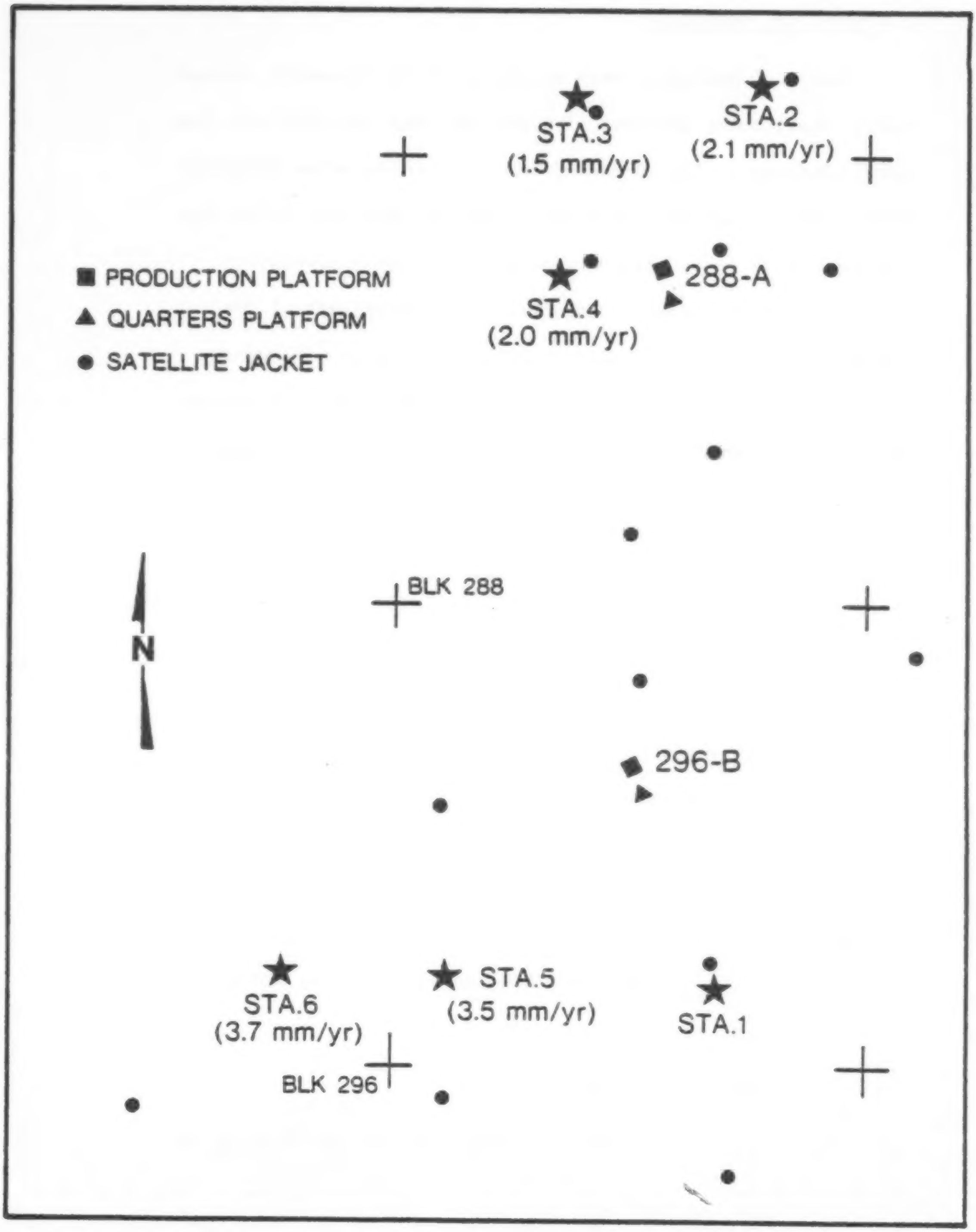
STA.3
(1.5 mm/yr)
STA.2
(2.1 mm/yr)
■ PRODUCTION PLATFORM
▲ QUARTERS PLATFORM
● SATELLITE JACKET
STA.4
(2.0 mm/yr)
288-A
BLK 288
N
296-B
STA.6
(3.7 mm/yr)
STA.5
(3.5 mm/yr)
STA.1
BLK 296

Figure 3.2.1 Locations of cores for Pb-210 dating. Sedimentation rates in parenthesis.

Table 3.2.1
Pb-210 ACTIVITY IN BUCCANEER FIELD

Station	Depth (cm)	Sample Weight	Extract Yield	Instrument DPM[1]	Background DPM[1]	Counter Efficiency	Pb-210 (dpm/gm)
Station 1	0-1	4.2783	86.34	4.82	2.52	0.49	1.27
	1-2	5.7147	87.58	6.06	2.52	0.49	1.44
	3-4	4.0741	86.66	5.44	2.52	0.49	1.69
	6-7	4.8203	87.19	4.05	2.23	0.48	0.90
	8-9	4.5209	86.45	5.22	2.52	0.49	1.41
	10-11	4.5012	87.21	5.27	2.23	0.48	1.61
	15-16	5.8049	83.29	4.41	2.52	0.49	0.80
	18-19	5.2271	85.72	4.05	2.23	0.48	0.85
	19-20	5.1762	85.12	3.70	2.52	0.49	0.55
			Sed. Rate = undeterminable				
Station 2	0-1	3.7361	84.33	5.75	2.52	0.49	2.09
	1-2	5.9047	82.71	6.24	2.52	0.49	1.55
	3-4	5.3564	85.81	5.92	2.52	0.49	1.51
	6-7	6.0391	81.43	3.10	2.23	0.48	0.37
	10-11	5.1171	82.16	3.74	2.52	0.49	0.59
	15-16	4.7578	82.88	3.46	2.52	0.49	0.49
	20-21	4.6213	81.56	3.57	2.52	0.49	0.57
	30-31	4.7256	84.04	3.28	2.23	0.48	0.55
	40-41	4.7057	79.43	4.15	2.52	0.49	0.89
	69-70	6.1091	76.31	3.47	2.23	0.48	0.55
			Sed Rate ≃ 2.1 mm/yr (over past 48 yr)				

---

[1] DPM = disintegrations per minute; dpm/gm = disintegrations per gram of sediment.

Table 3.2.1 (continued)

Station	Depth (cm)	Sample Weight	Extract Yield	Instrument DPM[1]	Background DPM[1]	Counter Efficiency	Pb-210 (dpm/gm)
Station 3	0-1	5.7933	79.56	6.34	2.52	0.49	1.69
	1-2	5.4169	89.71	4.95	2.52	0.49	1.02
	3-4	4.3169	86.68	4.42	2.52	0.49	1.04
	6-7	4.2805	87.81	2.87	2.23	0.48	0.35
	10-11	6.8250	84.70	4.21	2.52	0.49	0.60
	15-16	5.9039	84.72	3.55	2.52	0.49	0.42
	20-21	4.5373	90.37	3.52	2.52	0.49	0.50
	30-31	5.7573	86.00	3.14	2.23	0.48	0.38
	40-41	4.8288	86.62	3.88	2.52	0.49	0.66
	89-90	5.2418	79.79	2.20	2.23	0.49	-
Sed. Rate $\cong$ 1.5 mm/yr (over past 47 yr)							
Station 4	0-1	6.1012	86.08	5.31	2.52	0.49	1.08
	1-2	5.0017	77.72	4.74	2.52	0.49	1.17
	3-4	5.9520	75.50	4.20	2.52	0.49	0.76
	6-7	5.9085	76.06	3.27	2.23	0.48	0.48
	10-11	5.6356	83.52	3.81	2.52	0.49	0.56
	15-16	6.4587	83.76	3.41	2.52	0.49	0.34
	20-21	5.8696	80.11	3.39	2.52	0.49	0.38
	40-41	6.1331	81.16	3.98	2.52	0.49	0.60
Sed. Rate $\cong$ 2.0 mm/yr (over past 40 yr)							

---

[1] DPM = disintegrations per minute; dpm/gm = disintegrations per gram of sediment.

Table 3.2.1 (continued)

Station	Depth (cm)	Sample Weight	Extract Yield	Instrument DPM[1]	Background DPM[1]	Counter Efficiency	Pb-210 (dpm/gm)
Station 5	0-1	5.3029	85.59	5.35	2.52	0.49	1.27
	1-2	5.0262	84.74	5.21	2.52	0.49	1.34
	3-4	6.2529	76.70	5.46	2.52	0.49	1.25
	6-7	4.7561	81.82	3.72	2.23	0.48	0.80
	10-11	5.2622	83.57	3.91	2.52	0.49	0.65
	15-16	4.8919	82.82	3.32	2.52	0.49	0.40
	20-21	5.1874	81.80	3.38	2.52	0.49	0.41
	40-41	5.1746	88.86	3.45	2.52	0.49	0.41
Sed. Rate ≃ 3.5 mm/yr (over past 43 yr)							
Station 6	0-1	5.4315	81.26	5.18	2.52	0.49	1.23
	1-2	4.7709	85.34	4.80	2.52	0.49	1.14
	3-4	4.9927	79.90	4.65	2.52	0.49	1.09
	8-9	4.6561	83.16	3.51	2.52	0.49	0.52
	15-16	5.5365	79.79	3.60	2.52	0.49	0.50
	20-21	6.0689	81.11	3.03	2.23	0.48	0.21
	30-31	4.2707	81.75	3.17	2.52	0.49	0.56
	39-40	5.0590	81.66	3.36	2.23	0.48	0.41
Sed. Rate ≃ 3.7 mm/yr (over past 38 yr)							

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[1] DPM = disintegrations per minute; dpm/gm = disintegrations per gram of sediment.

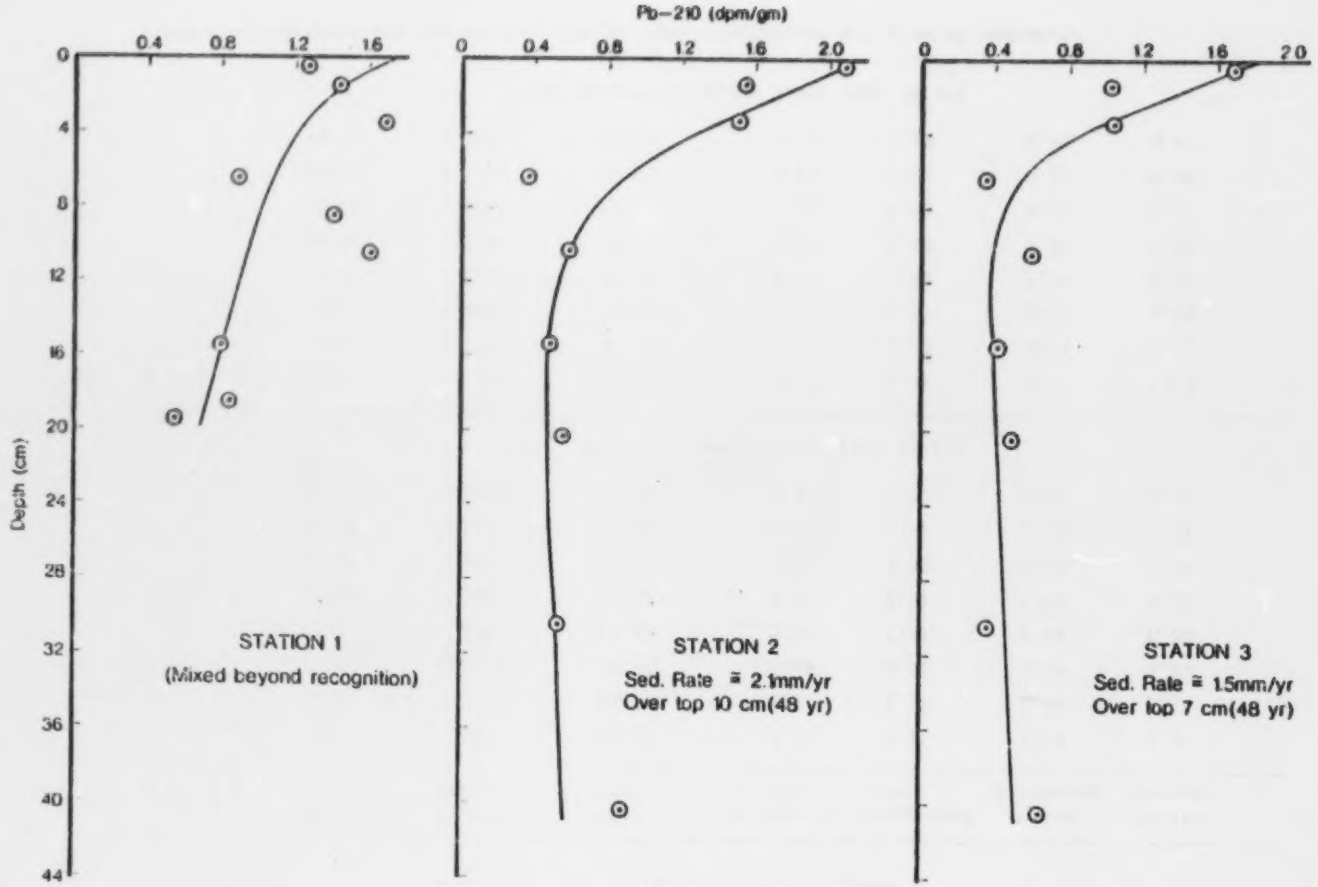

Figure 3.2.2 Pb-210 profiles in Buccaneer Field (see Figure 3.2.1 for location of stations).

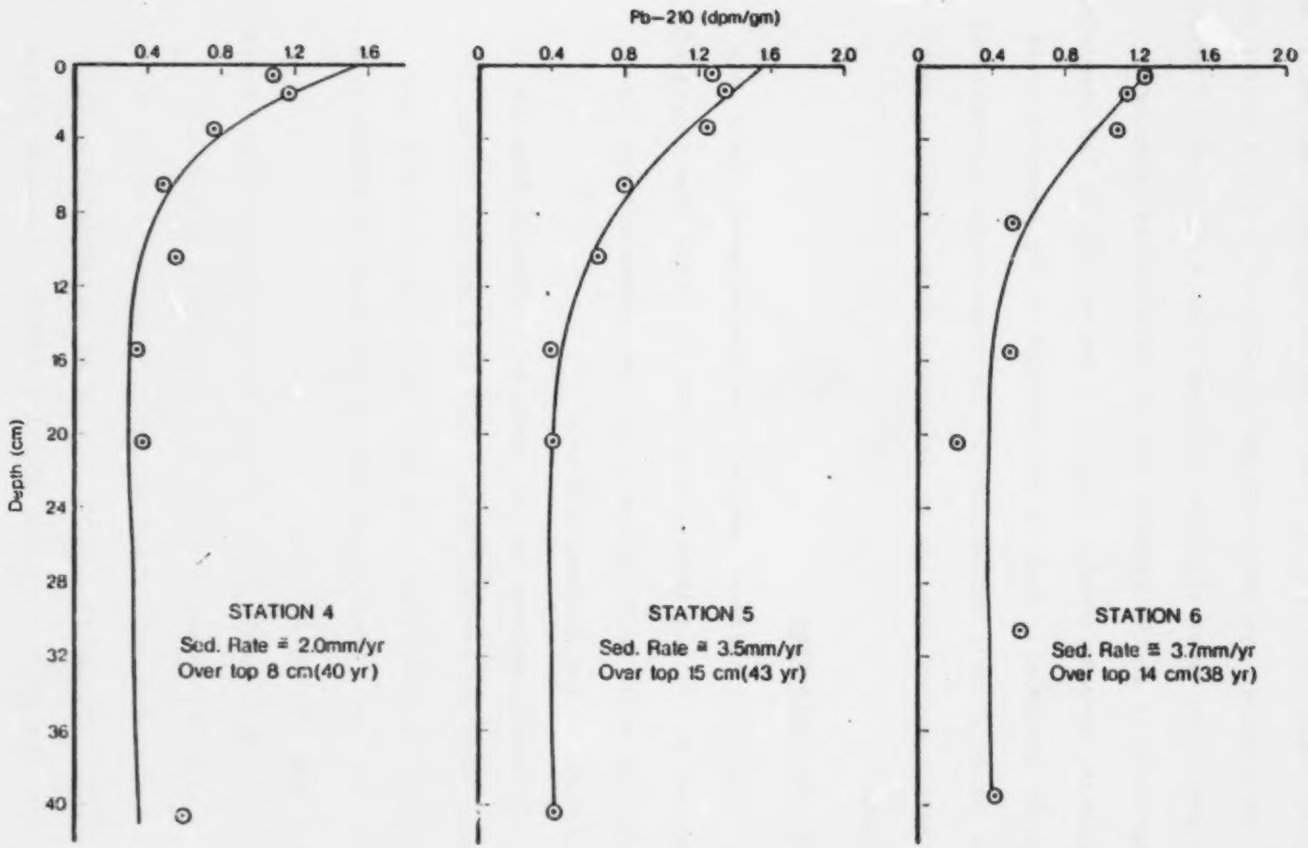

Figure 3.2.3 Pb-210 profiles in Buccaneer Field (see Figure 3.2.1 for location of stations).

six stations. Stations 2, 3 and 4 on the northern (shoreward) side of the platform are characterized by lower (1.5 to 2.1 mm/yr) effective sedimentation rates than are Stations 5 and 6 (3.5 and 3.7 mm/yr, respectively) on the seaward side of the platform (Station 1 sediments were apparently mixed to a degree that Pb-210 chronology was not possible). This is the opposite of the expected trend, and the only ready explanation is the down-current transport of materials either supplied or resuspended by the drilling operations.

3.2.2 Particle Size

Surficial sediment samples from the Buccaneer field were analyzed at 1/2 phi intervals or less for grain size (inorganic particles only) to determine grain size parameters and distribution of the sediment present.

Textural analyses on the surficial sediments from the summer sampling period (Table 3.2.2) at platforms 288 and 296, a satellite well jacket, and the flare stack, indicate that there existed a general decrease in mean grain size away from platforms 288 and 296.

The mean sample size at platform 288 (Figure 3.2.4) ranged from 1.00 phi 10 meters north of the platform to 6.80 phi (medium to fine silt-sized material) 50 meters north of the platform. The minimum particle size is particularly evident both to the north and south of the platform. The mean sample size data from platform 296 (Figure 3.2.5) shows that median

Table 3.2.2
SUMMER GRAIN SIZE ANALYSES

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	1	Below Disc.	1.50	1.55	3.18	0.13	1.12
296	2	10 M. N.	0.70	1.90	2.00	0.97	1.31
296	3	25 M. N.	3.82	4.80	2,52	0.53	3.17
296	4	50 M. N.	3.80	4.20	2.56	0.69	6.55
296	5	50 M. N.	3.75	4.32	2.04	0.69	4.14
296	6	50 M. N.	3.70	4.42	2.15	0.74	3.67
296	7	10 M. E.	3.50	2.53	3.34	-0.21	1.47
296	8	10.M. E	3.60	3.30	3.02	0.08	1.48
296	9	25 M. E.	0.35	0.77	2.26	0.30	1.34
296	10	50 M. E.	3.70	3.60	2.26	0.17	3.70
296	11	50 M. E.	3.15	3.85	2.31	0.58	3.05
296	12	10 M. S.	2.20	2.18	2.86	0.14	1.31
296	13	25 M. S.	3.75	4.43	2.43	0.44	3.53
296	14	50 M. S.	3.62	3.95	1.56	0.68	3.74
296	15	50 M. S.	3.75	4.08	1.64	0.67	3.94
296	16	10.M. W.	3.10	2.23	3.51	-0.19	1.32
296	17	25 M. W.	3.58	4.18	2.76	0.46	4.39
296	18	50 M. W.	4.40	4.32	1.90	0.08	4.84
288	19	Below Disc.	2.10	2.72	3.74	0.33	1.39
288	20	10 M. N.	0.50	1.00	3.83	0.27	1.22
288	21	25 M. N.	6.40	6.07	5.25	-0.02	0.74
288	22	50 M. N.	4.70	6.80	5.82	0.52	1.00
288	23	10 M. E.	4.80	5.93	5.23	0.34	0.80
288	24	25 M. E.	3.50	5.17	5.89	0.46	1.01
288	25	50 M. E.	3.75	5.79	4.43	0.65	1.15
288	26	10 M. S.	4.20	4.87	3.44	0.41	1.48
288	27	25 M. S.	4.70	6.37	4.76	0.48	0.95
288	28	50 M. S.	4.80	5.70	2.67	0.44	0.78
288	29	10 M. W.	1.30	3.20	4.67	0.56	1.54
288	30	25 M. W.	4.08	5.51	4.03	0.63	2.20
288	31	50 M. W.	3.90	4.60	2.86	0.57	5.25
288	32	50 M. W.	3.82	4.22	3.00	0.58	6.87
288-5	33	Well Jacket	2.80	3.87	6.88	0.24	0.92
296P	34	Flare Stack	3.25	3.33	0.85	-0.13	3.44
296P	35	Flare Stack	3.42	3.48	1.38	0.44	4.45

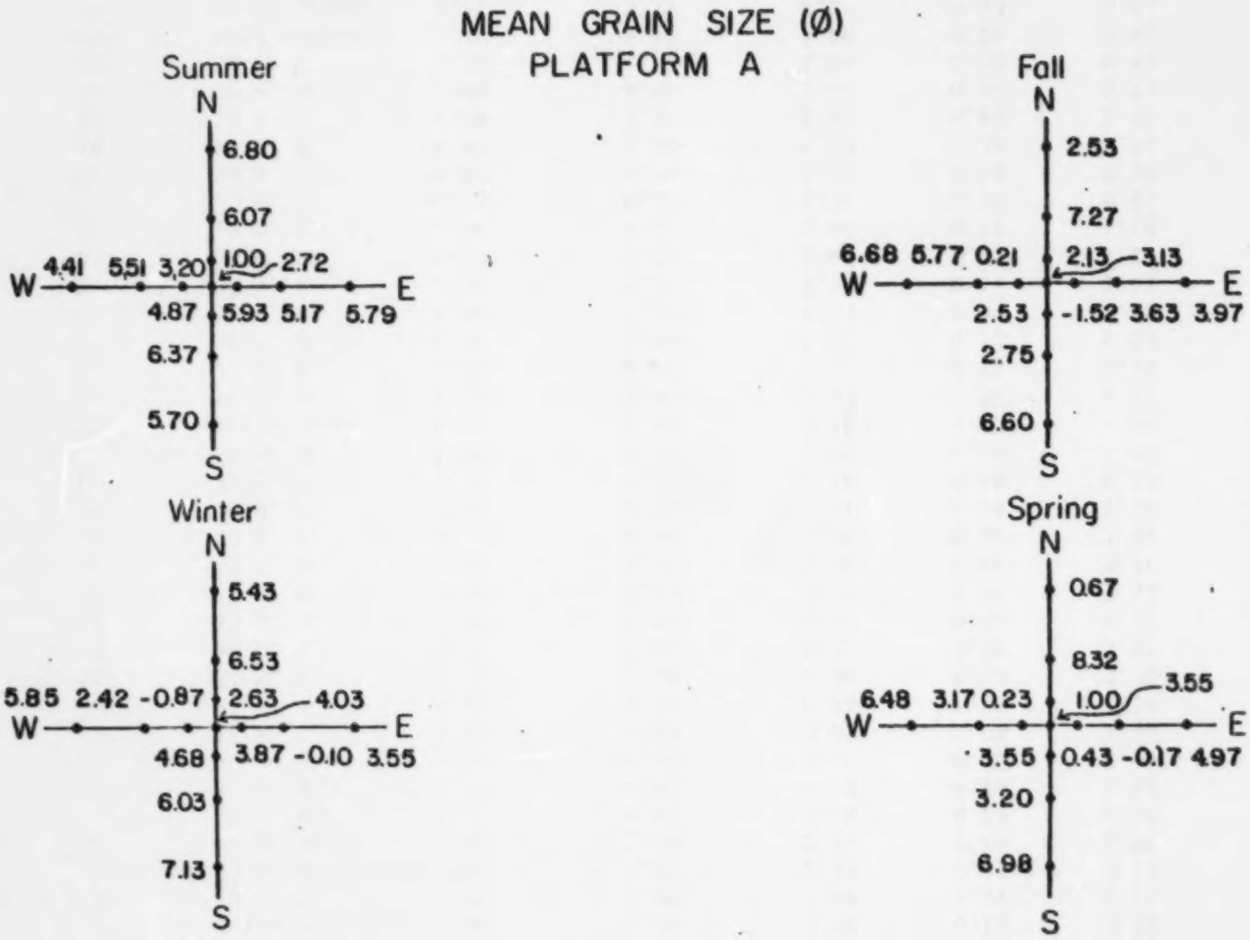
MEAN GRAIN SIZE (Ø)
PLATFORM A
Summer
N
6.80
6.07
4.41 5.51 3.20 1.00 2.72
W E
4.87 5.93 5.17 5.79
6.37
5.70
S
Fall
N
2.53
7.27
6.68 5.77 0.21 2.13 3.13
W E
2.53 -1.52 3.63 3.97
2.75
6.60
S
Winter
N
5.43
6.53
5.85 2.42 -0.87 2.63 4.03
W E
4.68 3.87 -0.10 3.55
6.03
7.13
S
Spring
N
0.67
8.32
6.48 3.17 0.23 1.00 3.55
W E
3.55 0.43 -0.17 4.97
3.20
6.98
S

Figure 3.2.4 Mean grain size distributions at Platform A during the seasonal samplings.

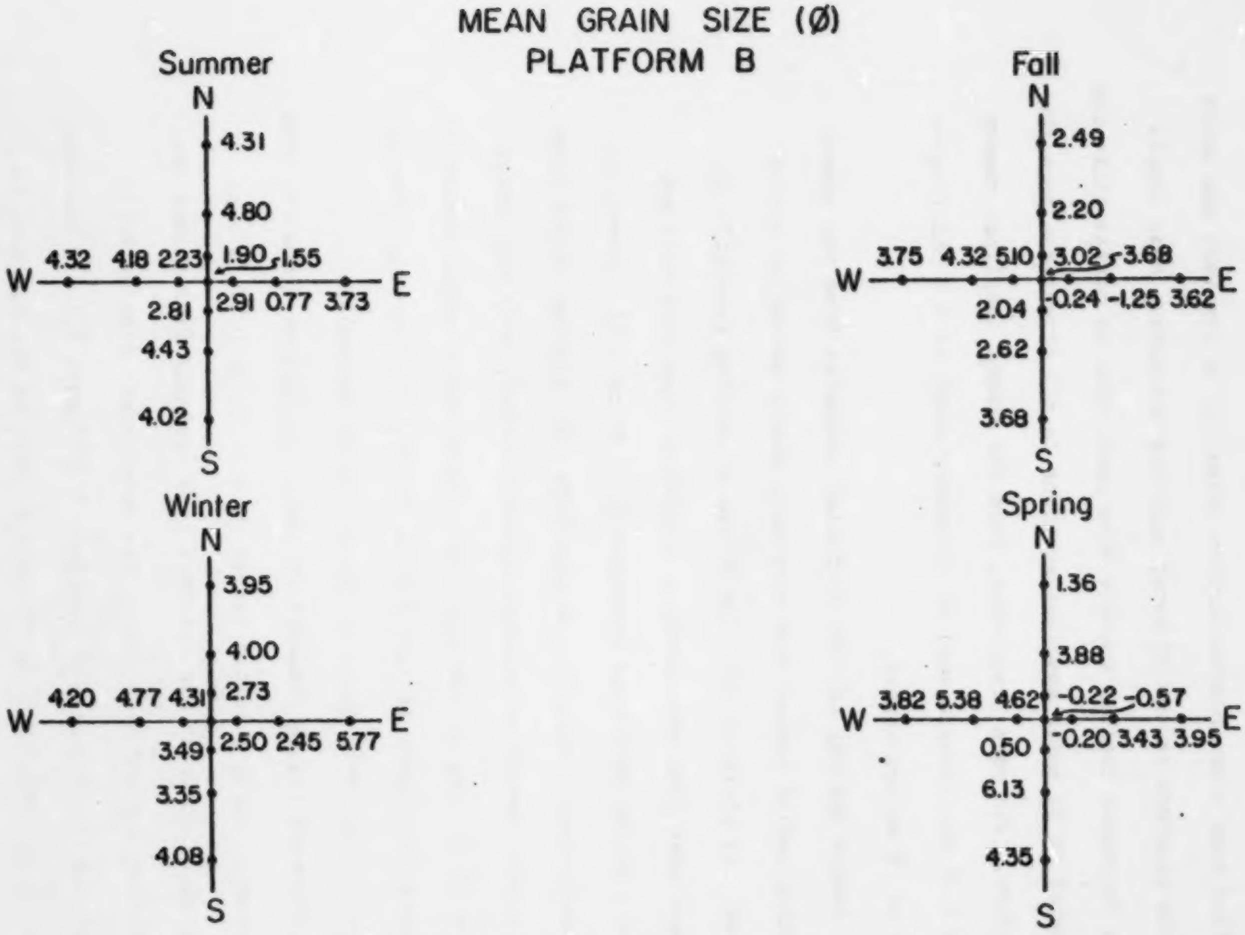
MEAN GRAIN SIZE (Ø)
PLATFORM B
Summer
N
4.31
4.80
4.32
4.18
2.23
1.90
1.55
W
E
2.81
2.91
0.77
3.73
4.43
4.02
S
Fall
N
2.49
2.20
3.75
4.32
5.10
3.02
3.68
W
E
2.04
-0.24
-1.25
3.62
2.62
3.68
S
Winter
N
3.95
4.00
4.20
4.77
4.31
2.73
W
E
3.49
2.50
2.45
5.77
3.35
4.08
S
Spring
N
1.36
3.88
3.82
5.38
4.62
-0.22
-0.57
W
E
0.50
-0.20
3.43
3.95
6.13
4.35
S

Figure 3.2.5 Mean grain size distributions at Platform B during the seasonal samplings.

to fine sand size material exists primarily to the west and south of the platform at the 25 meter sampling stations. Mean sample size decreases rapidly to very fine sand, then to coarse silt-size material at 50 meter sampling stations in all directions from the platform. The mean grain size, from the summer sampling, ranged from 0.77 phi (coarse sand at 25 meters east) to 4.8 phi (coarse silt at 25 meters north).

Sample sorting for the surficial sediments from the summer sampling period ranged from extremely poorly sorted to poorly sorted. At platform 296, the degree of sorting generally increased away from the platform, but at no time were even moderately sorted materials encountered (3.51 to 1.56 - poorly to extremely-poorly sorted). At platform 288, samples ranged from very poorly sorted to extremely-poorly sorted, with the lowest degree of sorting at the platform. These values would appear to indicate that there is very little sorting or winnowing effects present except very close to the platforms themselves.

Skewness values (measure of sample population symmetry) from the summer sampling period ranged from -0.21 to 0.97, a near symmetrical sediment distribution to a strongly fine-skewed one. The higher the skewness value, the more excess fine material present in the sample. At platform 288 (Figure 3.2.6), skewness values range from -0.02 at 25 meters north of the platform to 0.65 at 50 meters to the east. There also exists a general trend towards higher skewness values (a relative increase in

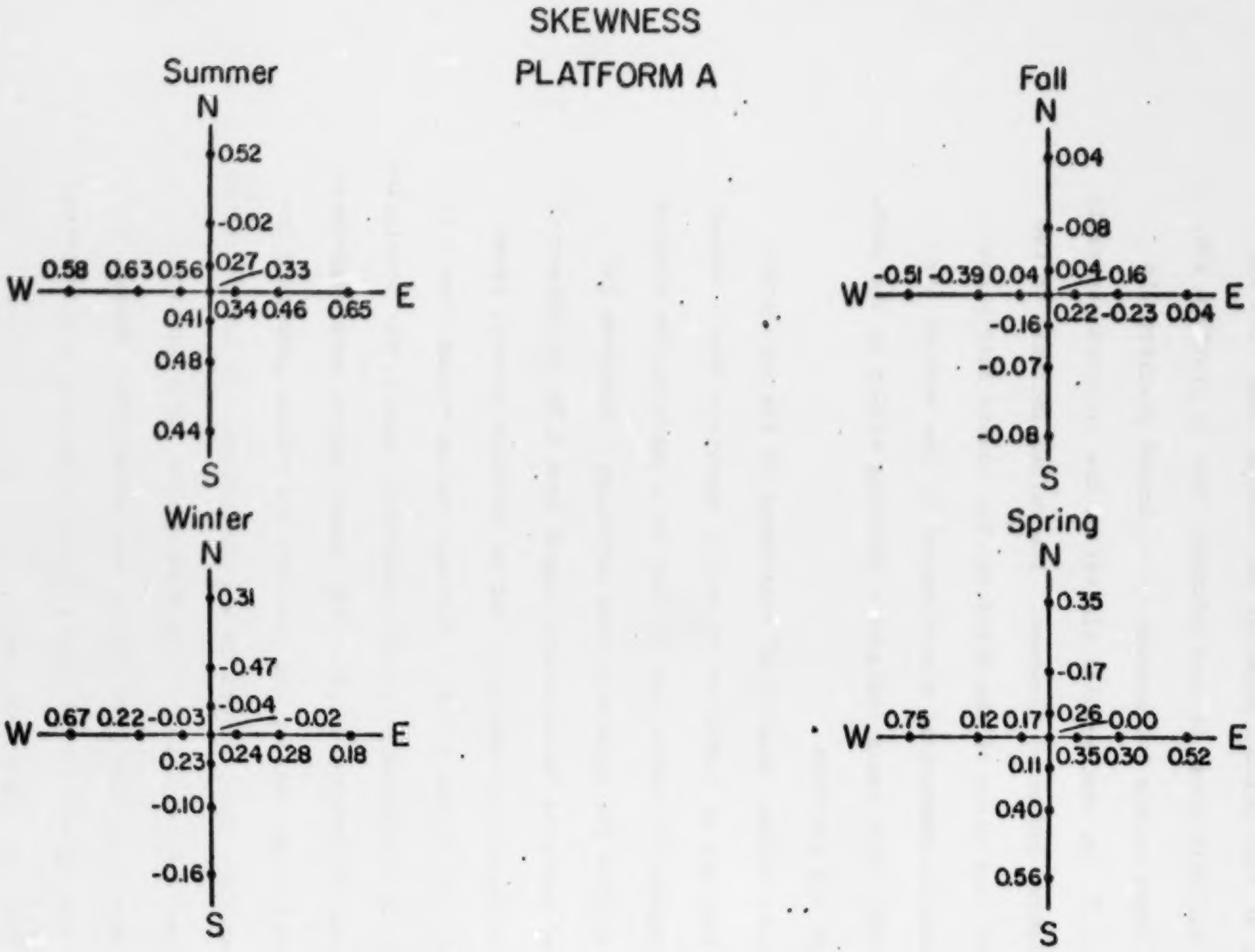
SKEWNESS
PLATFORM A
Summer
N
0.52
-0.02
W
0.58
0.63
0.56
027
0.33
E
0.41
0.34
0.46
0.65
0.48
0.44
S
Fall
N
0.04
-0.08
W
-0.51
-0.39
0.04
0.04
0.16
E
-0.16
0.22
-0.23
0.04
-0.07
-0.08
S
Winter
N
0.31
-0.47
W
0.67
0.22
-0.03
-0.04
-0.02
E
0.23
0.24
0.28
0.18
-0.10
-0.16
S
Spring
N
0.35
-0.17
W
0.75
0.12
0.17
0.26
0.00
E
0.11
0.35
0.30
0.52
0.40
0.56
S

Figure 3.2.6 Skewness in grain size at Platform A during the seasonal samplings.

the amount of fine-grained material per sample) away from the platform, but this trend is less dramatic than at platform 296. A general trend exists for samples taken around platform 296 (Figure 3.2.7), in that samples closest to the platform generally have the lowest degree of skewness. The values increase to the east, south, and north of the platform, but remain fairly constant (a nearly symmetrical distribution) to the west of the platform 296. This would indicate a scouring effect to the south and west of the platform.

Kurtosis values (measure of peakedness of the population distribution) are an indicator of sample departure from a normal gaussian population curve, and in fact is a quantitative measure used to describe the departure from normality. Platform 288 samples had kurtosis values which ranged from 0.78 (platykurtic) to 6.87 (extremely leptokurtic), but no definite spacial trends were noted (see Figure 3.2.8). Kurtosis values ranged from 1.12 (a mesokurtic population) to 6.55 (extremely leptokurtic population) at platform 296 (Figure 3.2.9). The lowest values were associated with samples taken nearest the platform and values generally increase away from the platform in all directions. It may be stated for platform 296, at least at the time of the first surficial sediment sampling, that populations were excessively peaked, or that the central portion of each population is more highly sorted than the tails of the population.

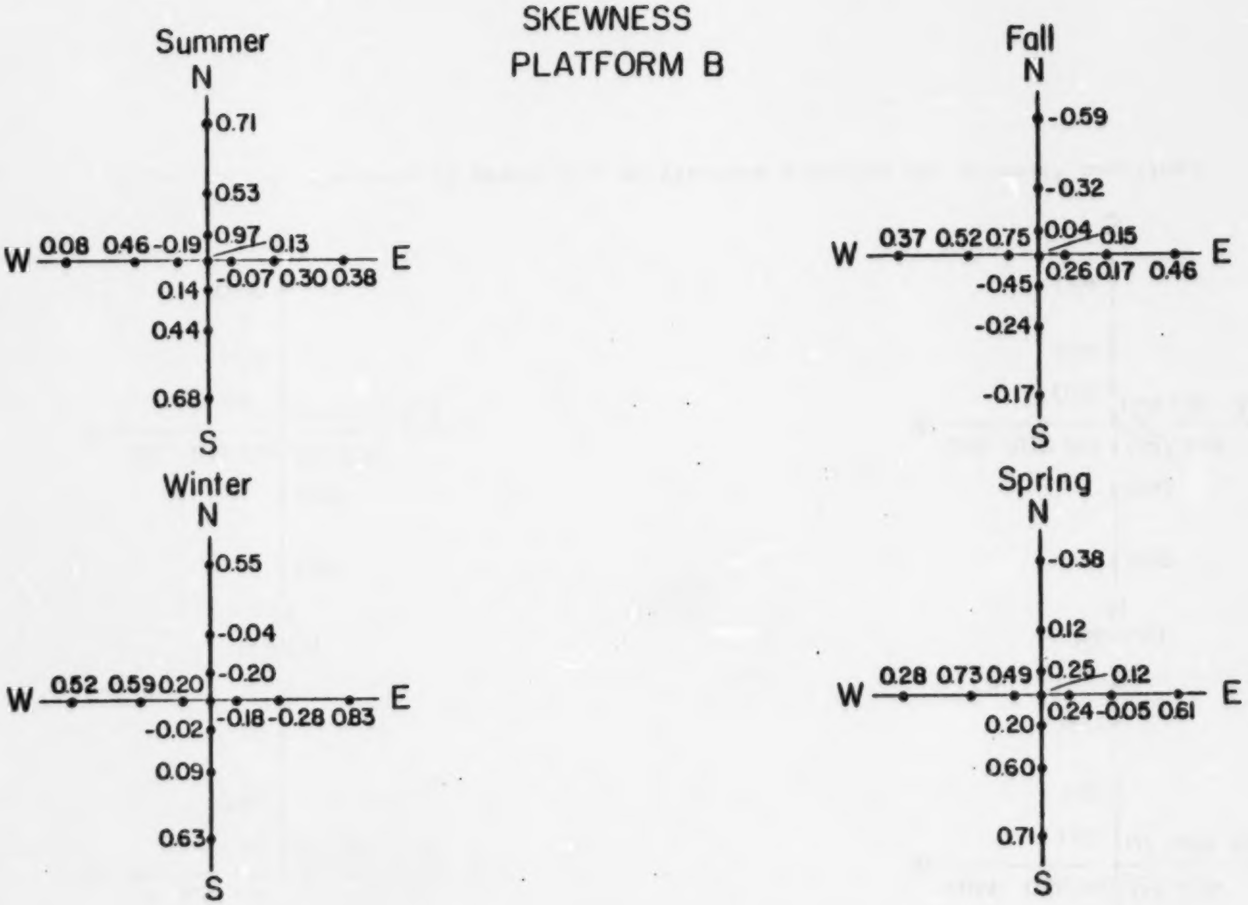
SKEWNESS
PLATFORM B
Summer
N
0.71
0.53
0.97
0.13
W
0.08
0.46
-0.19
E
-0.07
0.30
0.38
0.14
0.44
0.68
S
Fall
N
-0.59
-0.32
0.04
0.15
W
0.37
0.52
0.75
E
0.26
0.17
0.46
-0.45
-0.24
-0.17
S
Winter
N
0.55
-0.04
-0.20
W
0.52
0.59
0.20
E
-0.18
-0.28
0.83
-0.02
0.09
0.63
S
Spring
N
-0.38
0.12
0.25
0.12
W
0.28
0.73
0.49
E
0.24
-0.05
0.61
0.20
0.60
0.71
S

Figure 3.2.7 Skewness in grain size at Platform B during the seasonal samplings.

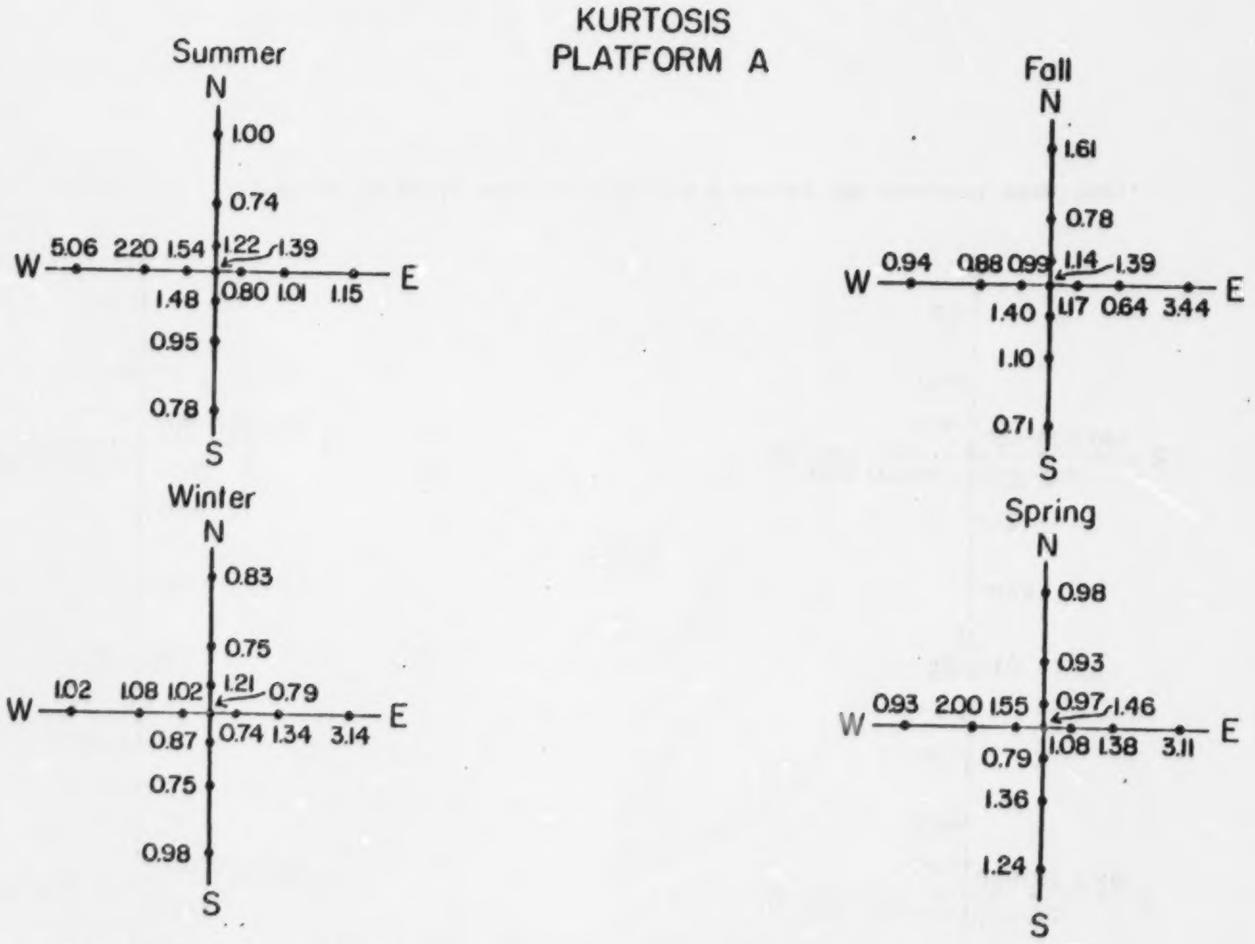

Figure 3.2.8 Kurtosis of grain size at Platform A during the seasonal samplings.

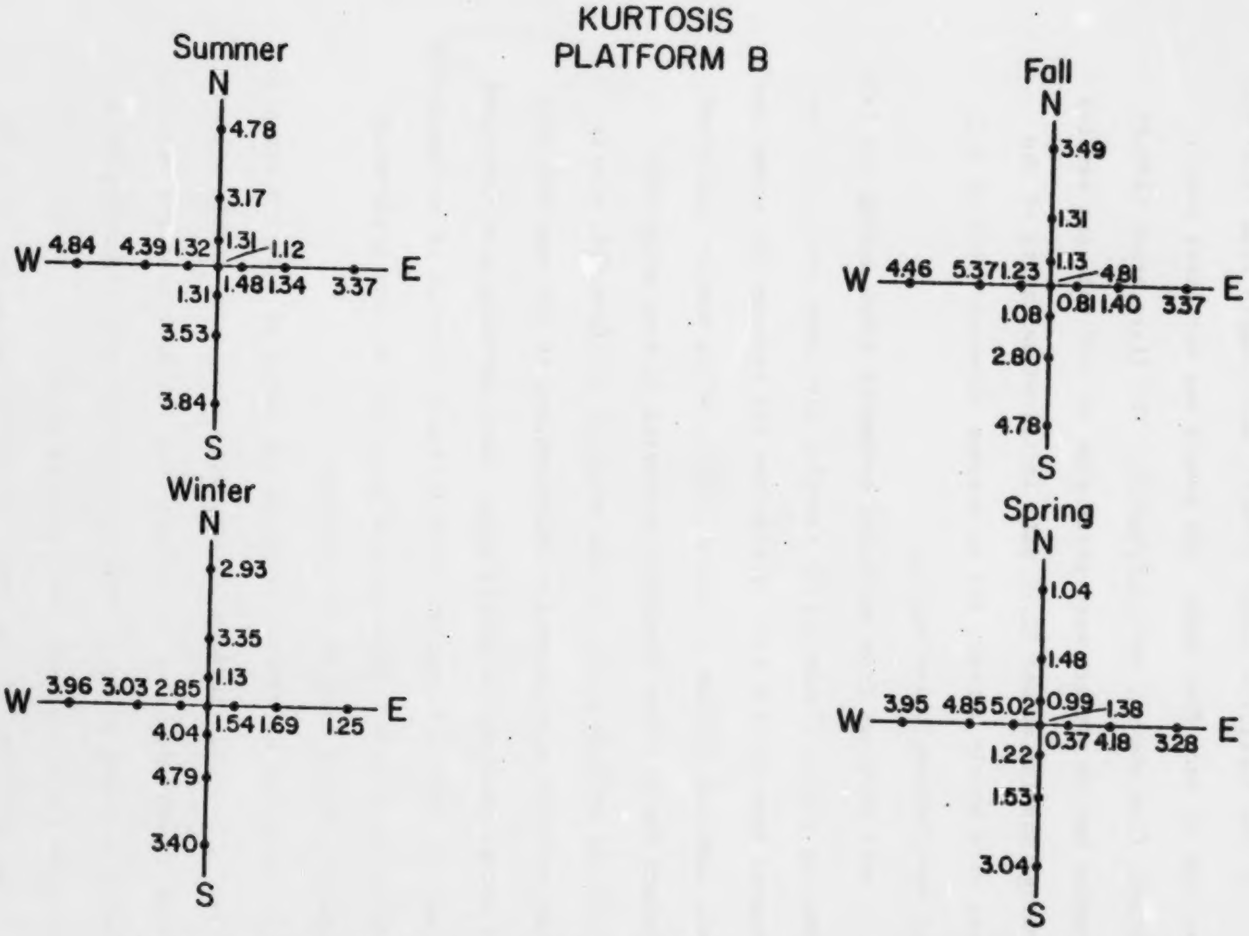

Figure 3.2.9 Kurtosis of grain size at Platform B during the seasonal samplings.

At the Satellite Jacket (288-5), mean sample size (3.87 phi) was that of very fine sand. The sample was extremely poorly sorted, fine skewed, and platykurtic. The flare stack (296-F) samples had an average mean grain size of 3.40 phi; the samples average sorting values (1.11 phi) indicated sediments of the area were poorly sorted, had an average skewness value of 0.15, and were extremely leptokurtic.

Data obtained from surficial sediments taken during the fall sampling period (Table 3.2.3) revealed that mean grain size increased dramatically east of platform 296 between the summer and fall sampling (Tables 3.2.2 and 3.2.3), while samples collected beneath the platform discharge decreased in mean grain size (1.55 phi to 3.68 phi). To the south of platform 296, sample mean particle size generally increased,and at the sampling site 10 meters west and 10 meters north, mean particle size decreased greatly. This information would indicate a period of sedimentation around the platform, but extreme winnowing of fine grain-sized material to the east of the platform.

In addition, samples taken to the north of the platform also showed a general decrease in skewness value, with sample values becoming more negative with time; that is, approaching a coarsely skewed sediment distribution, indicating a mild winnowing effect with the removal of some fine-grained material.

At platform 288, sediment size increased dramatically to the east (i.e., 5.93 phi to 2.75 phi), and the west (3.2 phi to 0.21 phi at 10 meters), but also generally decreased in size

Table 3.2.3

FALL GRAIN SIZE ANALYSES

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	122	Below Disc.	3.64	3.68	3.63	0.15	4.81
296	123	10 M. N.	3.20	3.02	2.08	0.04	1.13
296	124	25 M. N.	3.35	2.20	3.39	-0.32	1.31
296	125	50 M. N.	3.40	2.49	2.24	-0.59	3.49
296	126	10 M. E.	-0.90	-0.24	3.64	0.26	0.81
296	127	25 M. E.	-1.30	-1.25	1.86	0.17	1.40
296	128	50 M. E.	3.50	3.62	1.14	0.46	3.37
296	129	10 M. S.	3.35	2.04	3.32	-0.45	1.08
296	130	25 M. S.	3.56	2.62	3.35	-0.24	2.80
296	131	50 M. S.	3.62	3.68	1.46	0.17	4.78
296	132	10 M. W.	3.96	5.10	2.71	0.75	1.23
296	133	25 M. W.	3.71	4.32	2.51	0.52	5.37
296	134	50 M. W.	3.64	3.75	1.41	0.37	4.46
296	135	Below Disc.	4.10	3.83	3.42	-0.06	3.67
296	136	10 M. S.	3.20	1.77	3.44	-0.43	1.01
288	137	Below Disc.	3.00	3.13	4.39	0.16	1.39
288	138	10 M. N.	-2.10	2.13	2.62	0.04	1.14
288	139	25 M. N.	7.70	7.27	6.51	-0.08	0.78
288	140	50 M. N.	3.00	2.53	3.79	0.04	1.61
288	141	10 M. E	-1.65	-1.52	3.45	0.22	1.17
288	142	25 M. E.	4.30	3.63	4.95	-0.23	0.64
288	143	50 M. E.	3.82	3.97	3.07	0.07	3.44
288	144	10 M. S.	3.60	2.53	4.79	-0.16	1.40
288	145	25 M. S.	3.20	2.75	3.54	-0.07	1.10
288	146	50 M. S.	6.80	6.60	2.64	-0.08	0.71
288	147	10 M. W.	0.20	0.21	3.79	0.04	0.99
288	148	25 M. W.	6.80	5.77	3.74	-0.39	0.88
288	149	50 M. W.	7.40	6.68	3.25	-0.41	0.94
296B	150	Flare Stack	3.50	3.76	1.53	0.61	3.81
288-5	151	Cont. Jacket	5.20	3.98	4.71	-0.36	0.59

to the north (1.00 phi to 2.13 phi at the 10 meter sampling site). Mean sediment size also decreased somewhat below the discharge point (2.72 phi to 3.13 phi). Comparison of data from the summer and fall sediment samples indicated all skewness values had decreased, with all sample populations showing an increase (an excess) of coarse sized material. This would be the case if winnowing of the fine material by currents, wave energy, etc., caused a relative increase in the amount of coarse material present.

At the satellite jacket, site 288-5, the mean particle size collected during the fall sampling was 3.98 phi, slightly smaller than that determined for summer sampling. The sorting value decreased from 6.88 phi to 4.71 phi, still extremely poorly sorted, while the skewness value dropped to -0.36, from 0.24 recorded for summer samples. These data indicate that at the satellite jacket, while mean size dropped only slightly between sampling periods, there was a definite increase in the amount of coarse-grained material present within the sample. This would probably indicate a winnowing effect whereby some of the finer-grained material was removed.

At the flare stack (296-F), the only significant change in sediment particle parameters between samplings was a slight decrease in mean grain size. This would indicate that the only effective geologic activity is very mild sedimentation of fine grain-sized material between summer and fall.

Data extracted from surficial sediment samples collected during the winter sampling is presented in Table 3.2.4.

At Platform 296 (Figure 3.2.5), mean grain size generally decreased relative to fall samples, with the exception of samples collected at sites 10 meters north and west of the platform, where a mild increase in mean grain size occurred. Relative to fall sample data, skewness values decreased in all samples north and east, increased to the south, and decreased substantially at 10 meters west of the platform. The decrease in skewness shows a tendency for all samples to contain a larger percentage of coarse grain-sized material.

These data would indicate a period of winnowing has occurred between the fall and winter samplings; the increase in both mean grain size and skewness data at stations 10 meters north and west would indicate extreme winnowing in these areas.

At platform 288, no clear areal distribution trends in mean grain-size were apparent when comparing fall and winter sediment data. One exception was a consistent, but small, increase in mean grain size to the west of platform 288. The same lack of trends holds for skewness data, again with the exception of one sample to the west of the platform (at 50 meters) which increased dramatically (-0.41 to 0.67), indicating a large apparent addition of finer grain-sized material. The addition of fine-grained material through sedimentation away from the platform appears consistent with increased winnowing due to current flow

Table 3.2.4

WINTER GRAIN SIZE ANALYSES

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
296	544	Below Disc.					
296	545	10 M. N.	3.40	2.73	3.50	-0.20	1.13
296	546	25 M. N.	4.10	4.00	2.16	-0.04	3.35
296	547	50 M. N.	3.70	3.93	1.49	0.55	2.93
296	548	10 M. E.	3.40	2.50	4.06	-0.18	1.54
296	549	25 M. E.	3.35	2.45	3.20	-0.28	1.69
296	550	50 M. N.	4.30	5.77	2.78	0.83	1.25
296	551	10 M. S.	4.02	3.49	3.48	-0.02	4.04
296	552	25 M. S.	3.75	3.35	3.53	0.09	4.79
296	553	50 M. S.-1	3.50	3.83	1.55	0.53	3.28
296	554	50 M. S.-2	3.80	4.33	1.95	0.73	3.52
296	555	10 M. W.	3.82	4.37	4.10	0.20	2.85
296	556	25 M. W.-1	3.80	4.06	3.73	0.37	3.30
296	557	25 M. W.-2	3.95	5.48	3.14	0.82	1.62
296	558	50 M. W.	3.80	4.20	1.92	0.52	3.96
288	559	Below Disc.	4.10	4.03	4.65	-0.02	0.79
288	560	10 M. N.	4.30	2.63	3.87	-0.04	1.21
288	561	25 M. N.	8.40	6.53	5.75	-0.47	0.75
288	562	50 M. N.	4.10	5.43	4.68	0.31	0.83
288	563	10 M. E.	3.00	3.87	5.27	0.24	0.74
288	564	25 M. E.	-0.50	-0.10	3.61	0.28	1.34
288	565	50 M. E.	3.45	3.55	2.99	0.18	3.14
288	566	10 M. S.	4.05	4.68	5.16	0.23	0.87
288	567	25 M. S.	6.30	6.03	4.84	-0.10	0.75
288	568	50 M. S.	7.40	7.13	4.01	-0.16	0.98
288	569	10 M. W.	-0.80	-0.87	1.93	-0.03	1.02
288	570	25 M. W.	2.20	2.42	3.46	0.22	1.08
288	571	50 M. W.	4.44	5.85	3.07	0.67	1.02
288-5	572	Sat. Jacket	3.10	3.35	4.52	0.03	0.59
296F	573	Flare Stack	3.75	4.23	1.89	0.65	3.46

nearer the platform.

At the satellite jacket (site 288-5), sample mean grain size increased slightly from fall to winter (3.98 phi to 3.35 phi, respectively). There was little change in sorting values during this period (4.71 phi to 4.52 phi), no change in kurtosis, and an increase in skewness values (-0.36 to 0.03) from strongly coarse skewed to a near symmetrical sediment distribution.

Flare stack sample sediment data indicated a mild decrease in mean sediment particle size, a decrease in sorting, and little change in skewness and kurtosis values when comparing fall and winter sediment parameter data.

From the spring 1979 sampling, the following information was obtained (Table 3.2.5). Below the discharge at platform 296, the mean sediment size (-0.56 phi) was that of very coarse sand-sized material. To the east, the mean grain size became progressively finer. This areal trend was also noted in the winter samples. One major change occurred between the winter and spring sampling at the east 10 meter collection site, where the mean grain size decreased dramatically (0.50 phi to -0.20 phi), indicating extremely active winnowing. To the south and north of the platform, at the 10 meter site, this effect was also present.

To the west, the mean particle size first decreased (4.62 phi to 5.38 phi) from 10 to 25 meters, then increased (to 3.82 phi) at the 50 meter site. Skewness values also followed this trend with increasing distance from the platform (0.49, 0.73, 0.28),

Table 3.2.5

SPRING GRAIN SIZE ANALYSES

Station	Sample No.	Location	Median Grain Size (Ø)	Mean Grain Size (Ø)	St. Dev. (Ø)	Skewness	Kurtosis
288-5	1061	Sat. Jacket	3.60	3.76	5.65	0.00	0.61
296-F	1062	Flare Stack	3.35	3.52	2.29	0.14	4.21
288	1063	Below Disc.	4.05	3.55	4.28	0.00	1.46
288	1064	10 M. N.	0.50	1.00	3.13	0.26	0.97
288	1065	25 M. N.	9.50	8.32	7.21	-0.17	0.93
288	1066	50 M. N.	0.00	0.67	3.28	0.35	0.98
288	1067	10 M. E.	-0.70	0.43	3.86	0.35	1.08
288	1068	25 M. E.	-0.70	-0.17	3.59	0.30	1.38
288	1069	50 M. E.	3.40	4.97	4.02	0.52	3.11
288	1070	10 M. S.	2.90	3.55	5.05	0.11	0.79
288	1071	25 M. S.	2.00	3.20	5.17	0.40	1.36
288	1072	50 M. S.	4.95	6.98	5.00	0.56	1.24
288	1073	10 M. W.	0.10	0.23	2.97	0.17	1.55
288	1074	25 M. W.	3.50	3.17	4.45	0.12	2.00
288	1075	50 M. W.	4.45	6.48	3.86	0.75	0.93
296	1076	Below Disc.	-0.60	-0.57	2.23	0.12	1.38
296	1077	10 M. N.	-1.00	-0.32	3.18	0.25	0.99
296	1078	50 M. N.	2.60	1.67	3.13	-0.38	1.04
296	1079	10 M. E.	-0.70	-0.20	2.73	0.24	0.37
296	1080	25 M. E.	3.80	3.87	3.84	0.19	4.18
296	1081	50 M. E.	3.60	3.95	1.64	0.61	3.28
296	1082	10 M. S.	0.05	0.50	2.37	0.20	1.22
296	1083	25 M. S.	4.20	6.13	4.67	0.60	1.53
296	1084	50 M. S.	3.75	4.35	1.79	0.71	3.04
296	1085	10 M. W.	3.75	4.62	3.21	0.49	5.02
296	1086	25 M. W.	3.90	5.38	3.63	0.73	4.85
296	1087	50 M. W.	3.75	3.82	1.57	0.28	3.95
296	1088	50 M. N.(Rep)	1.85	1.05	2.78	-0.42	0.76
296	1089	25 M. E.(Rep)	3.65	2.98	3.75	-0.10	1.48
296	1090	25 M. N.	3.75	3.88	2.28	0.12	5.35

while kurtosis values decreased with distance from the platform. This data would indicate that with increasing distance to the west of the platform, the sediment population becomes more normally distributed.

Ten meters to the north of the center of platform 296, the mean sediment size (-0.32 phi) is in the coarse sand size range but decreases to fine sand size (3.88 phi) material at 25 meters. The 25 meter sample also had an unusual kurtosis value of 5.35, indicating extreme sorting in the central portion of the sample sediment distribution. At 50 meters north, the average mean grain size was that of medium sand-sized material (1.36 phi). This sample also had an average skewness value of -0.40 (strongly coarse skewed).

At platform 288, fine grained sand-sized material was the mean particle size below the discharge, and the sample had a normal skewness; i.e., a normal sediment population distribution. Between the winter and spring sampling, this site exhibited only a slight increase in mean sediment size.

East of platform 288, sediment mean particle size was fairly coarse at 10 and 25 meter sites (0.43 phi and -0.17 phi, respectively), but fairly fine grained (4.97 phi) at 50 meters. With increasing distance from the platform, the samples tended to be increasingly skewed toward the fine fraction, and all samples become more positively skewed (more fine-grained material present) when compared to winter data. This would indicate active fine-grained sedimentation to the east of the platform.

South of platform 288, mean sediment particle size generally decreased with increasing distance from the platform, and samples taken at 25 and 50 meters exhibited a dramatic increase in skewness values when comparing winter to spring data. This indicates active fine-grained sedimentation in the area.

To the west, mean grain size dropped dramatically, increasingly skewed towards the fine fraction. All samples to the west also decreased in mean grain size when comparing winter to spring samples, again indicating active sedimentation.

To the north, active winnowing is apparent only at the 10 meter sample site, as evidenced by a decrease in mean grain size from 2.63 phi present during the winter sampling to 1.00 phi at the spring sampling. The 25 meter site data also indicates fine-grained sedimentation has occurred away from the platform between the winter and spring samplings.

At the satellite jacket, the mean sediment size had decreased slightly from winter to spring sampling (3.35 phi to 3.76 phi). Sorting became slightly poorer and skewness and kurtosis values were unchanged. It appears that the only geological activity effecting the satellite jacket was very mild sedimentation of fine-grained material.

The flare stack sample had a slightly coarser mean-grain size at the spring sampling than was present at the winter sampling; sorting decreased mildly (1.89 phi to 2.29 phi); skewness values dropped to 0.14 from 0.65 for the winter sample, and kurtosis values increased. The increase in skewness values between seasons indicates a relative decrease in the amount of fine grain-size material present. The above information would indicate that mild winnowing was the main geologic process active during the winter-spring period.

3.2.3 Organic and Carbonate Content

Surficial sediments were collected along transects aligned north, east, south and west of the platforms with sampling stations at 10, 25 and 50 meters from the brine discharge pipe. Well jacket and flare stack samples were also collected. Percent organic carbon, percent $CaCO_3$ and respective $\delta^{13}C$ values were determined for both summer and winter samples. The results for platforms 288A and 296B can be found in Tables 3.2.6 through 3.2.9 and Figures 3.2.10 through 3.2.13.

Organic carbon content for platform 288A (Figure 3.2.10) showed a decreasing gradient away from the platform during the summer sampling period. Figure 3.2.10 also shows a fairly predominant northeast flux of organic carbon (i.e., anonomously high values, 0.34 % and 0.39 % found at sites 10 meters north and east, respectively) which may be a reflection of prevailing east-northeast bottom currents during the summer months (Armstrong, 1978). In this case, sediments below and surrounding the platform which are relatively high in organic carbon

Table 3.2.6

ORGANIC AND CALCIUM CARBONATE CARBON IN SEDIMENTS, SUMMER, PLATFORM A

STATION	DISTANCE	Org. C (%)	$\delta^{13}C$ (°/∘∘)	$CaCO_3$ (%)	$\delta^{13}C$ (°/∘∘)
DISCHARGE	0 m	0.32	-21.1	23.8 (34.8)	-1.9 (+0.0)
North	10 m	0.34	-20.0	50.3	-1.7
	25 m	0.30	-20.7	15.2	0.0
	50 m	0.20	-20.5	19.3	-1.6
South	10 m	0.23	-21.8	14.9	-2.0
	25 m	0.18	-20.6	15.0	-1.8
	50 m	0.28 (0.30)	-20.5 (-21.0)	7.3 (13.8)	-0.1 (-0.1)
East	10 m	0.39	-22.0	16.8	-2.2
	25 m	0.29	-21.0	26.7	-0.1
	50 m	0.24	-21.8	6.4	0.4
West	10 m	0.23	-21.5	13.0	-0.9
	25 m	0.23	-20.5	7.8	0.3
	50 m	0.17	-21.3	3.6	0.3
Flare Stack		0.18	-20.2	2.6	-1.3

Number in parenthesis represent replicates.

Table 3.2.7

ORGANIC AND CALCIUM CARBONATE CARBON IN SEDIMENTS, SUMMER, PLATFORM B

STATION	DISTANCE	Org. C (%)	$\delta^{13}C$ (°/₀₀)	$CaCO_3$ (%)	$\delta^{13}C$ (°/₀₀)
DISCHARGE	0 m	0.30	-21.9	30.1 (24.1)	0.6 (0.7)
North	10 m	0.39	-21.2	74.0	0.5
	25 m	0.23	-20.9	13.3	0.8
	50 m	0.19	-22.2	4.8	0.9
South	10 m	0.27	-20.5	36.2 (32.1)	-0.2 (0.6)
	25 m	0.11	-21.5	11.1	0.9
	50 m	0.17	-20.1	2.5	-1.5
East	10 m	0.25 (0.19)	-21.2 (-22.7)	27.1	1.1 (1.1)
	25 m	0.36	-20.7	52.8	1.3
	50 m	0.14 (0.14)	-20.5 (-20.5)	3.1 (9.3)	0.3 (1.0)
West	10 m	0.23	-22.3	18.0 (19.4)	-1.7
	25 m	0.26	-22.7	7.2	1.0
	50 m	0.16 (0.14)	-21.1 (-20.8)	13.4	1.1
Well Jacket		0.30	-20.1	20.5	-0.6

Number in parenthesis represent replicates

Table 3.2.8

ORGANIC AND CALCIUM CARBONATE CARBON IN SEDIMENTS, WINTER, PLATFORM A

STATION	DISTANCE	Org. C (%)	$\delta^{13}C$ (°/₀₀)	$CaCO_3$ (%)	$\delta^{13}C$ (°/₀₀)
DISCHARGE	0 m	0.28	-21.8	8.2	-0.5
North	10 m	0.48	-23.1	20.7	-0.4
	25 m	1.23	-23.1	4.2	-0.5
	50 m	0.21	-22.5	16.7	+0.8
South	10 m	0.22	-20.5	10.2	+0.1
	25 m	0.59	-23.6	21.0	-0.6
	50 m	0.41	-21.9	4.0	-1.2
East	10 m	0.50	-24.3	7.8	-0.6
	25 m	0.42	-23.5	41.9	-0.2
	50 m	0.18	-23.3	13.7	+1.3
West	10 m	0.70	-22.7	43.4	+0.6 (+0.2)
	25 m	0.29	-22.3	11.6	+0.2
	50 m	0.31	-21.8	11.1	+0.2
Flare Stack		0.26	-22.2	6.1	+0.8

Number in parenthesis represent replicates.

Table 3.2.9

ORGANIC AND CALCIUM CARBONATE CARBON IN SEDIMENTS, WINTER PLATFORM B

STATION	DISTANCE	Org. C (%)	$\delta^{13}C$ (°/oo)	$CaCO_3$ (%)	$\delta^{13}C$ (°/oo)
DISCHARGE	0 m	0.28	-19.5	19.6	+0.2
North	10 m	0.24	-21.0	11.7	+1.1
	25 m	0.18	-21.2	4.9	+1.1
	50 m	0.20	-21.2	4.6	+0.8
South	10 m	0.36	-23.3	7.3	+0.8
	25 m	0.29	-23.2	4.9	+2.1
	50 m	0.16 (0.16)	-21.6 (-21.1)	4.9 (5.1)	+0.9 (+0.6)
East	10 m	0.19	-21.5	12.9	+1.0
	25 m	0.21	-21.6	20.3	+1.1
	50 m	0.22	-21.0	3.4	+0.3
West	10 m	0.35	-22.5	40.0	-2.1
	25 m	0.45 (0.22)	-22.7 (-22.6)	2.8	-0.1
	50 m	0.47	-22.6	2.3	-0.1
Well Jacket		0.41	-21.9	9.6	-0.3

Number in parenthesis represent replicates.

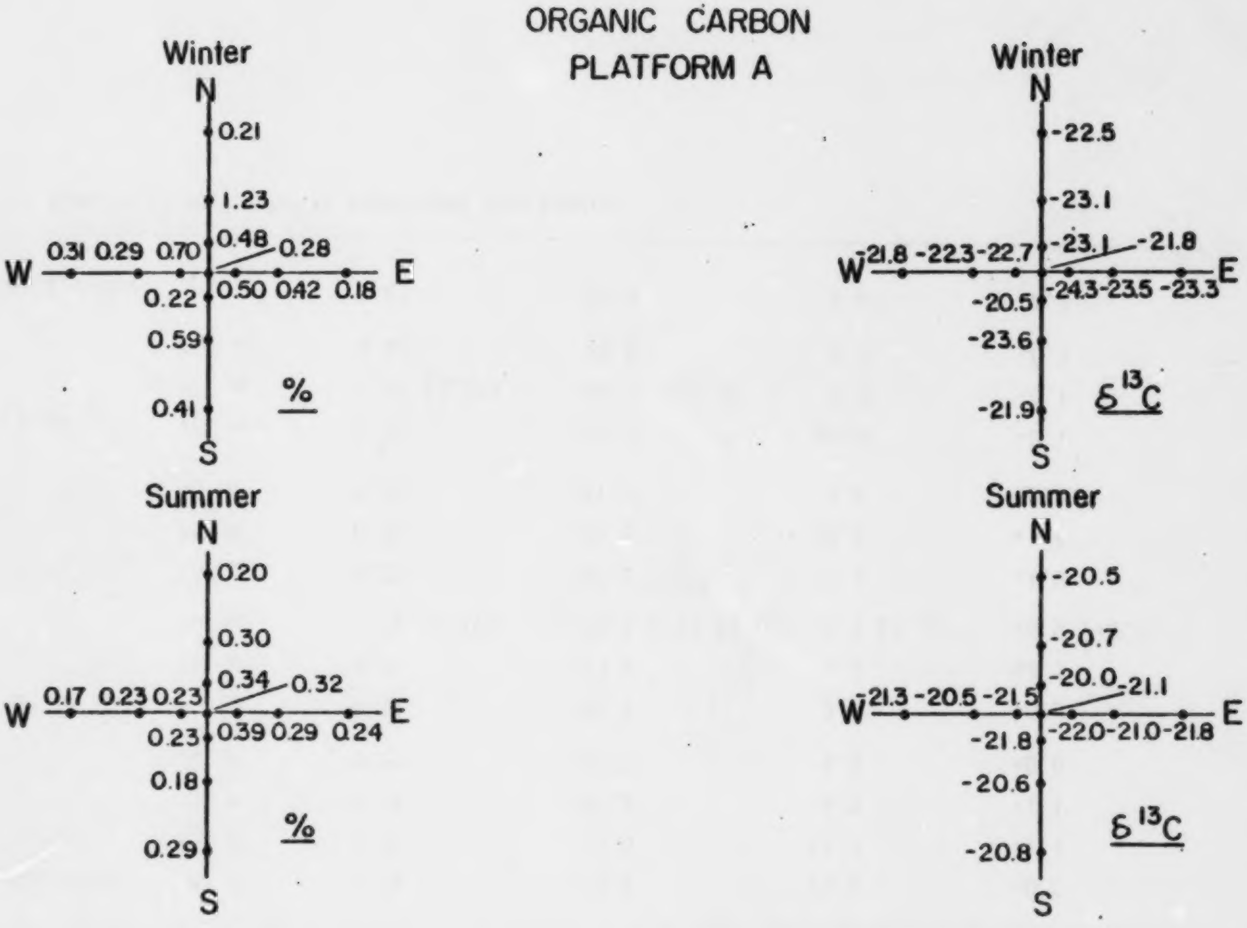
ORGANIC CARBON
PLATFORM A
Winter
N
0.21
1.23
0.31 0.29 0.70
0.48
0.28
W
E
0.22
0.50 0.42 0.18
0.59
0.41
S
%
Summer
N
0.20
0.30
0.17 0.23 0.23
0.34
0.32
W
E
0.23
0.39 0.29 0.24
0.18
0.29
S
%
Winter
N
-22.5
-23.1
-21.8 -22.3 -22.7
-23.1
-21.8
W
E
-20.5
-24.3 -23.5 -23.3
-23.6
-21.9
S
δ 13C
Summer
N
-20.5
-20.7
-21.3 -20.5 -21.5
-20.0
-21.1
W
E
-21.8
-22.0 -21.0 -21.8
-20.6
-20.8
S
δ 13C

Figure 3.2.10 Percent organic carbon and carbon isotope distributions at Platform A during the seasonal samplings.

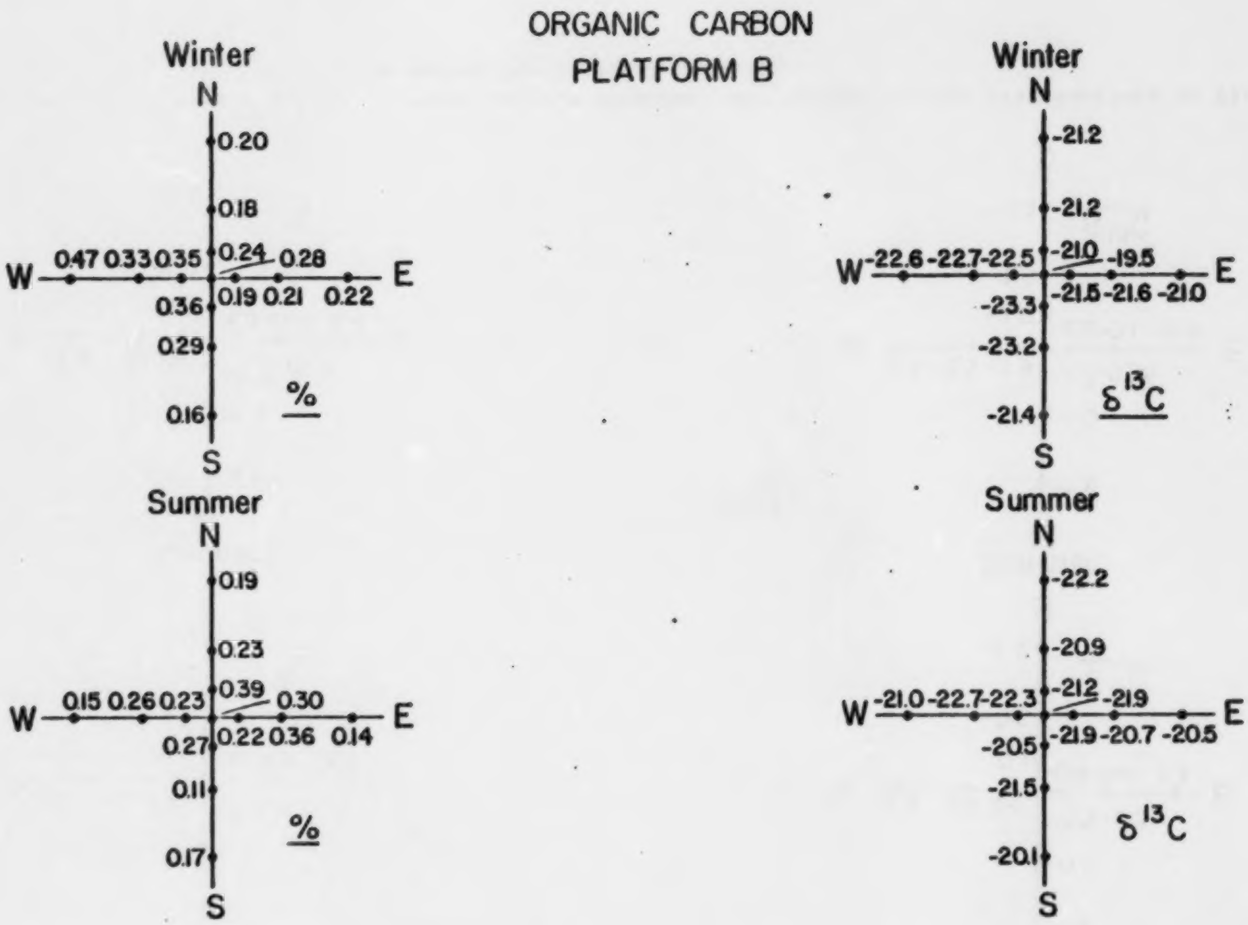

Figure 3.2.11 Percent organic carbon and carbon isotope distributions at Platform B during the seasonal samplings.

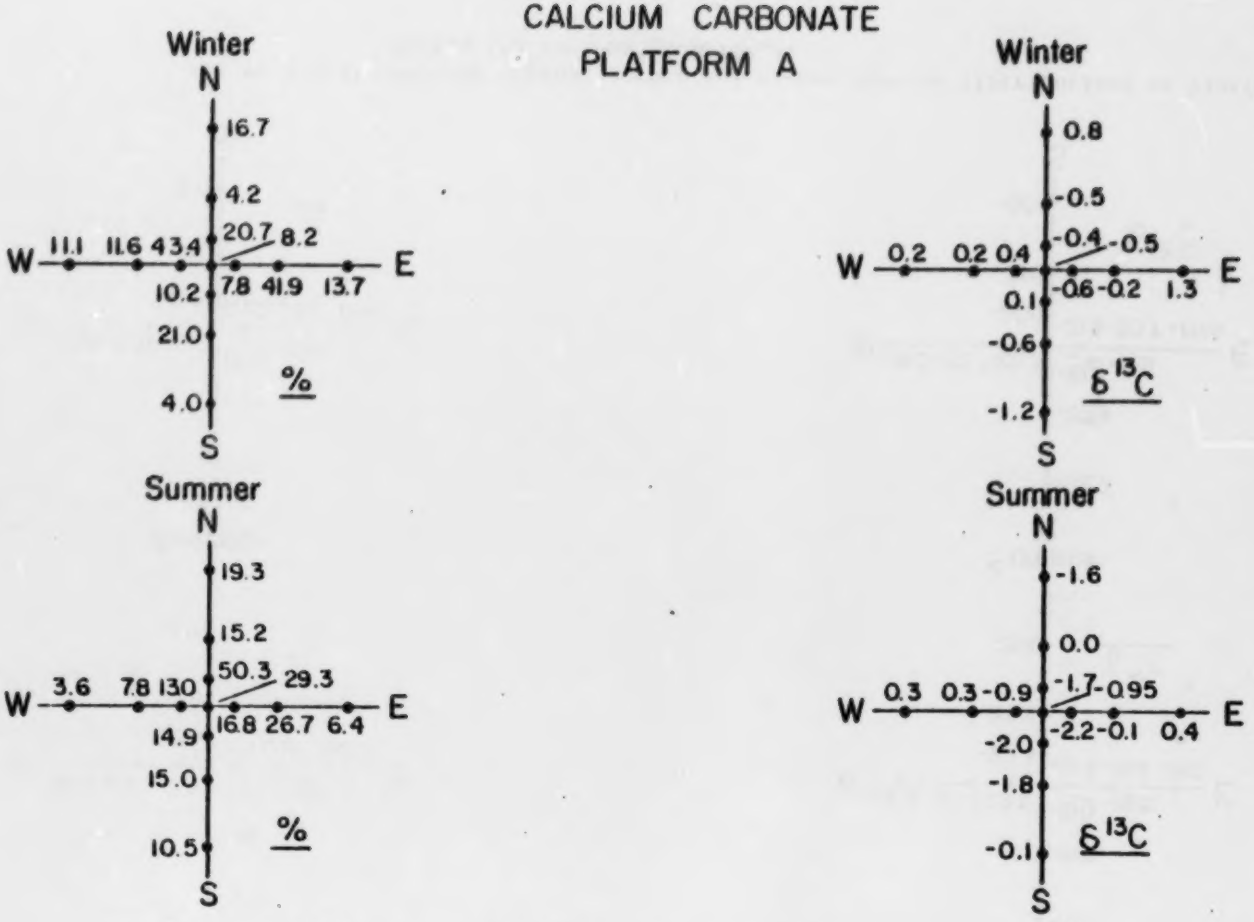
CALCIUM CARBONATE
PLATFORM A
Winter
N
S
W
E
16.7
4.2
20.7
8.2
11.1
11.6
43.4
10.2
7.8
41.9
13.7
21.0
4.0
%
Summer
19.3
15.2
50.3
29.3
3.6
7.8
130
14.9
16.8
26.7
6.4
15.0
10.5
%
Winter
0.8
-0.5
-0.4
-0.5
0.2
0.2
0.4
0.1
-0.6
-0.2
1.3
-0.6
-1.2
δ 13C
Summer
-1.6
0.0
-1.7
-0.95
0.3
0.3
-0.9
-2.0
-2.2
-0.1
0.4
-1.8
-0.1
δ 13C

Figure 3.2.12 Percent calcium carbonate and carbon isotope distributions at Platform A during the seasonal samplings.

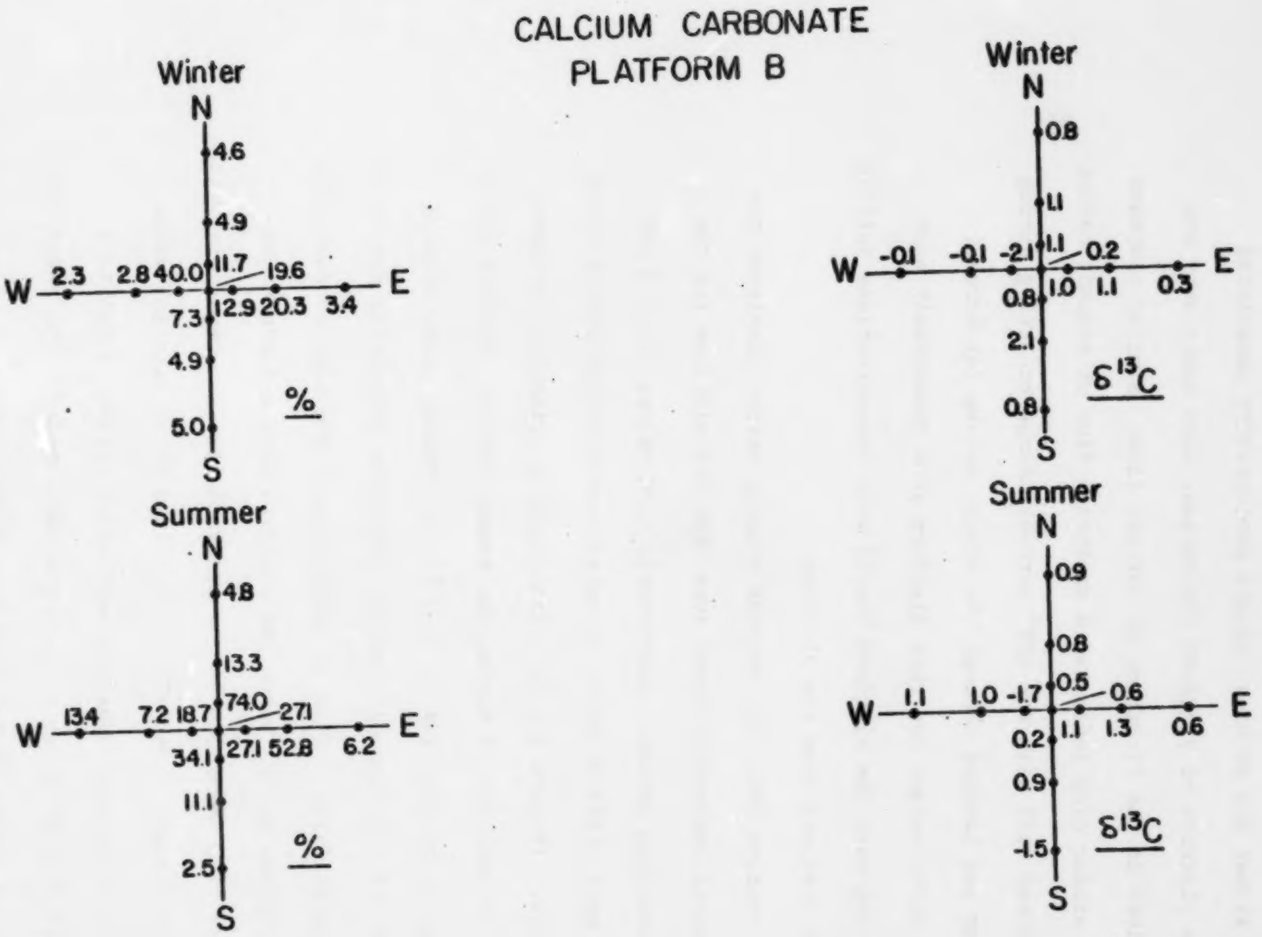

Figure 3.2.13 Percent calcium carbonate and carbon isotope distribution at Platform B during the seasonal samplings.

content, either due to high organic productivity associated with the platform or platform discharges, were swept away and redeposited in the direction of current flow. Similar contours for the winter data indicated a southerly flux of organic carbon which agreed well with the 180° current change occurring during September and lasting through the winter months (Armstrong, 1978). $CaCO_3$ values for this platform were anomonously high beneath and near the platform itself with concentrations tailing off with distance from the platform.

At station 296B, the percent organic carbon displayed the same general decreasing trend away from the platform for the summer sampling period. Anomonously high values (0.39 % and 0.36 %) were noted at sites 10 meters north and 25 meters south, respectively (Figure 3.2.11), indicating a primarily northeast flux of organic carbon during the summer months. Percent $CaCO_3$ was found to be high (up to 74.0 %) for samples taken beneath and near the platform with values generally decreasing out to the 50 meter sites. This is indicative of the high productivity in the surface waters below the platform with a further contribution from barnacles on the platform itself. Especially high values were again found (74.0 % and 52.8 %) at sampling sites 10 meters north and 25 meters east which further supports a northeast flux of material during summer months. The respective $\delta^{13}C$ values appear normal with no distinct trends.

For the winter sampling of platform 288A, organic carbon concentrations tend to support a southwestern material flux except for an anonomously high concentration (1.23 %) of organic carbon found at site 25 meters north. This high organic concentration may be a result of winnowing, since this site contained an excess of fine grained material. For the winter sampling of platform 296B, a decreasing trend of organic carbon concentrations away from the platform is not as apparent as in the summer data. Values are anomously high along the western and southern transects indicating a southwestern flux of material away from the platform. This is consistent with the 180° current change occurring during September and lasting through the winter months (Armstrong, 1978). $\delta^{13}C$ values display no apparent trend although values are somewhat lighter than samples collected during the previous summer. Although $CaCO_3$ concentrations are somewhat lower than the summer values, higher concentrations are still noted near and beneath the platform. The respective $\delta^{13}C$ values remain essentially unchanged seasonally.

$\delta^{13}C$ versus percent organic carbon has been plotted for both summer and winter samples collected around platform 288A and is shown in Figure 3.2.14. It can be seen that the summer data points all lie within a relatively narrow range of both $\delta^{13}C$ and percent organic carbon and reflect normal open marine pelagic value. The winter data points, however, are markedly lighter in isotopic composition and show a general increase in percent organic carbon. One possible explanation for this observation

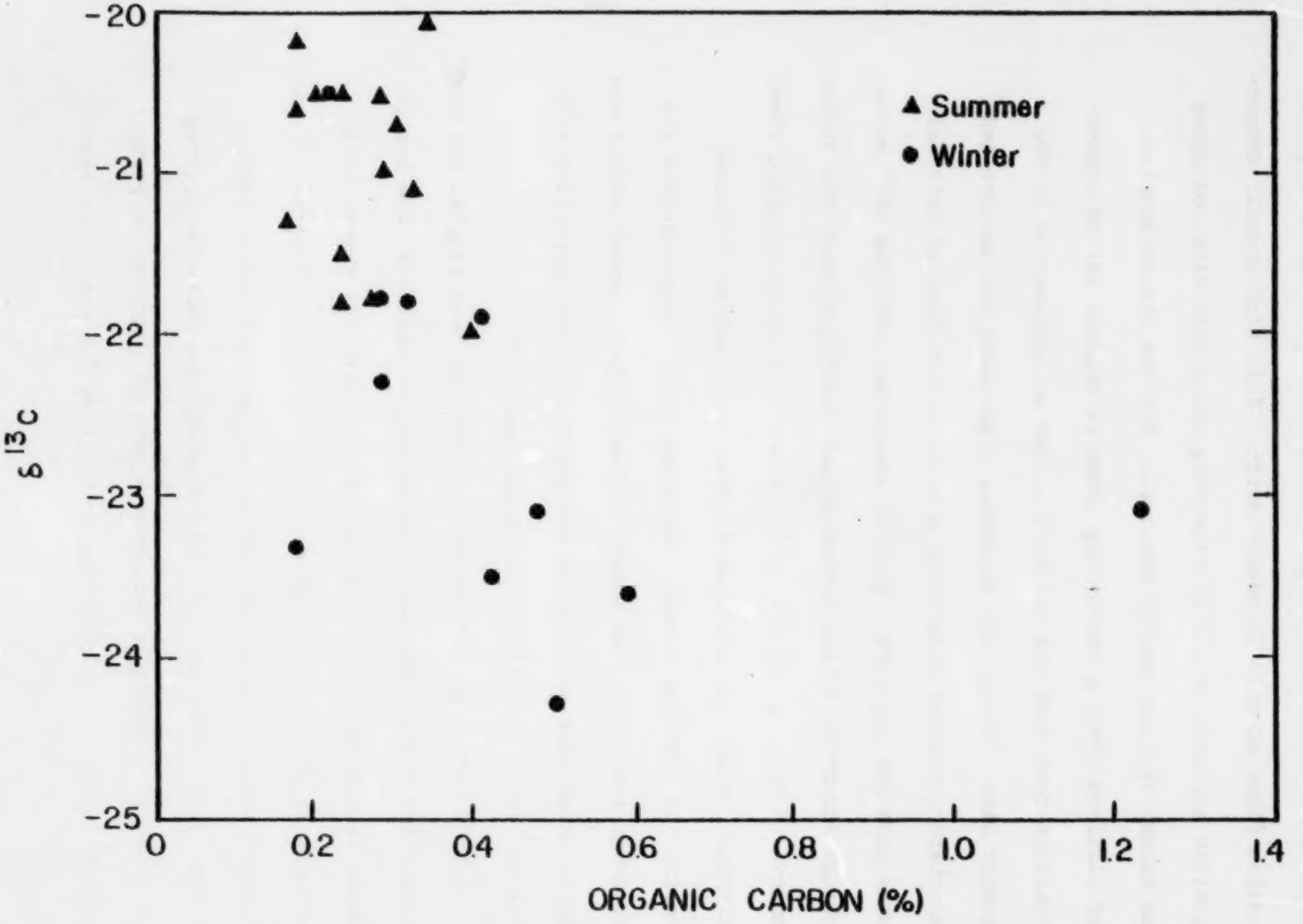

Figure 3.2.14 Percent organic carbon versus $\delta^{13}C$ from Platform A during both summer and winter samplings.

is that the sediments might be receiving a greater terrestrial contribution from coastal bays and estuaries during the winter months. The $\delta^{13}C$ of terrestrial organic carbon is generally about -27 °/oo versus PDB whereas open marine values are closer to -20 °/oo versus PDB. An increase in the terrestrial component would therefore tend to lower the observed $\delta^{13}C$ values.

Another explanation can be derived from bottom current considerations as discussed above. It must first be assumed, however, that sediment contamination due to platform discharges are sufficient to account for a marked change in both $\delta^{13}C$ and percent organic carbon in the sediments. This may be possible considering the high percentage of organic carbon and correspondingly light $\delta^{13}C$ values for the brine discharge. With this in mind, we might expect the prevailing east-northeast summer current to transport and redeposit contaminated sediments away from the platform. This would result in percent organic carbon and $\delta^{13}C$ values around the platform corresponding to normal open marine to very slightly contaminated sediments. With the 180° current change during the spring, however, contaminated sediments might be redeposited around the study area along with more recently contaminated sediments resulting in a cumulative effect. This mechanism seems even more likely when one considers the extreme bioturbation known to occur in the upper few centimeters of sediment which tends to disperse and resuspend finer grained material. This would explain the percent organic carbon increase as well as a decrease in the $\delta^{13}C$ as observed. A similar explanation was used by Middleditch and West (1979) to account for their observation of higher alkane concentrations in the sediments around platform 288A during the winter months.

3.2.4 Clay Mineralogy

Surficial sediments were analyzed in two stages: bulk analysis and oriented clay analysis. Only slight trends in clay mineral distribution were observed with respect to season or position in the water column.

3.2.4.a Bulk Analysis

The bulk analysis shows that the clay concentration in both the summer and winter samples is low (Tables 3.2.10 and 3.2.11). There is less clay around the platforms in the winter samples than in the summer samples. The distribution of clay at 288-A and 296-B, as well as at 288-5 and 296 flare stack, appears to be random. Quartz appears to be more abundant in the winter samples than in the summer samples. The remaining minerals are either less abundant or approximately equal. Barite was found in only one sample and was probably due to drilling mud contamination. The occurrence of barite near the platforms was also reported by Anderson et al. (1978). There are no definite trends in the distribution of the various minerals.

3.2.4.b Clay Analysis

The percent of smectite is less around platform A than

Table 3.2.10

BULK MINERALOGY IN SEDIMENTS, SUMMER, 1978

Station	Location	Halite[1]	Quartz[1]	Feldspars[1]	Plagioclase[1]	Calcite[1]	Dolomite[1]	Total of Clay Minerals[1]	Barite[1]
288	10 M.N.	3.0	38.0	3.0	5.0	19.0	0.0	32.0	0.0
288	25 M.N.	2.0	50.0	5.0	7.0	2.0	2.0	39.0	0.0
288	50 M.N.	2.0	38.0	4.0	10.0	4.0	1.0	41.0	0.0
288	10 M.E.	1.0	42.0	8.0	9.0	3.0	1.0	36.0	0.0
288	25 M.E.	3.0	41.0	7.0	7.0	4.0	2.0	36.0	0.0
288	50 M.E.	2.0	43.0	13.0	10.0	3.0	1.0	28.0	0.0
288	10 M.S.	2.0	39.0	30.0	6.0	1.0	1.0	21.0	0.0
288	25 M.S.	2.0	47.0	4.0	6.0	2.0	0.0	39.0	0.0
288	50 M.S.	2.0	40.0	4.0	19.0	2.0	1.0	32.0	0.0
288	10 M.W.	3.0	41.0	8.0	5.0	4.0	1.0	38.0	0.0
288	25 M.W.	2.0	56.0	8.0	9.0	2.0	1.0	22.0	0.0
288	50 M.W.	2.0	56.0	4.0	8.0	3.0	1.0	26.0	0.0
288	288WJ	3.0	41.0	3.0	6.0	7.0	0.0	37.0	0.0
288	2880	2.0	65.0	1.0	6.0	3.0	0.0	23.0	0.0
296	10 M.N.	9.0	14.0	6.0	3.0	24.0	0.0	44.0	0.0
296	25 M.N.	1.0	48.0	7.0	6.0	2.0	1.0	35.0	0.0
296	50 M.N.	1.0	64.0	6.0	9.0	1.0	1.0	18.0	0.0
296	10 M.E.	3.0	58.0	16.0	8.0	3.0	0.0	12.0	0.0
296	25 M.E.	5.0	57.0	6.0	3.0	4.0	0.0	20.0	5.0
296	50 M.E.	2.0	48.0	8.0	14.0	2.0	1.0	27.0	0.0
296	10 M.S.	3.0	47.0	11.0	7.0	4.0	2.0	26.0	0.0
296	25 M.S.	1.0	44.0	18.0	10.0	1.0	1.0	25.0	0.0
296	50 M.S.	1.0	53.0	11.0	9.0	1.0	0.0	25.0	0.0
296	10 M.W.	3.0	41.0	10.0	6.0	1.0	1.0	38.0	0.0
296	25 M.W.	3.0	66.0	4.0	7.0	1.0	0.0	19.0	0.0
296	50 M.W.	1.0	40.0	5.0	6.0	1.0	0.0	47.0	0.0
296	0	0.0	64.0	10.0	8.0	4.0	2.0	12.0	0.0
296	296-FS	0.0	69.0	5.0	2.0	2.0	0.0	22.0	0.0

---

[1] Values represent percent of bulk minerals.

Table 3.2.11

BULK MINERALOGY IN SEDIMENTS, WINTER, 1978

Station	Location	Halite[1]	Quartz[1]	Feldspars[1]	Plagioclase[1]	Calcite[1]	Dolomite[1]	Total of Clay Minerals[1]
288	10 M.N.	2.0	74.0	15.0	0.0	4.0	1.9	2.0
288	25 M.N.	4.4	74.1	4.4	6.8	3.9	2.8	3.6
288	50 M.N.	1.2	92.6	2.1	1.2	0.6	1.5	0.8
288	10 M.E.	5.1	79.6	0.0	4.4	4.2	2.1	4.6
288	25 M.E.	3.8	64.0	2.3	22.2	3.3	0.0	4.5
288	50 M.E.	0.8	84.0	2.7	0.7	0.4	0.0	8.8
288	10 M.S.	1.4	89.5	2.9	2.5	1.3	1.4	1.0
288	25 M.S.	1.7	80.0	0.0	15.3	1.4	0.0	2.1
288	50 M.S.	1.7	79.6	8.7	2.8	0.9	2.8	3.4
288	10 M.W.	2.4	52.8	3.2	2.6	6.7	2.0	8.5
288	25 M.W.	26.8	62.2	3.1	5.2	0.0	0.0	2.8
288	50 M.W.	1.3	90.8	2.7	2.5	1.3	0.0	1.4
288	Discharge	2.6	70.9	22.4	0.0	1.7	0.4	2.0
296	10 M.N.	1.1	62.0	7.2	25.3	1.5	1.4	1.4
296	25 M.N.	0.7	88.0	1.9	5.7	1.0	1.1	1.6
296	50 M.N.	0.7	89.9	2.5	4.6	0.9	0.0	1.5
296	10 M.E.	1.4	83.6	4.5	5.9	1.6	1.5	1.5
296	25 M.E.	0.7	74.6	3.4	17.1	0.9	0.6	2.7
296	50 M.E.	1.0	73.6	4.1	13.2	0.9	1.2	5.9
296	10 M.S.	0.4	84.6	3.7	7.9	1.7	0.9	0.7
296	25 M.S.	0.3	96.4	1.2	1.3	0.4	0.0	0.5
296	50 M.S. (1)	1.3	80.8	2.4	8.9	1.0	0.7	4.6
296	10 M.W.	2.0	74.4	4.4	11.1	3.2	3.9	0.8
296	25 M.W. (1)	0.7	86.0	9.4	2.0	0.4	0.5	1.0
296	50 M.W.	2.1	78.7	5.0	8.3	0.0	0.8	4.8
296	Discharge	4.5	83.8	3.4	6.1	0.9	0.0	1.3
296	Flair	1.5	80.1	5.5	7.8	1.2	0.8	3.0
296	50 M.S. (2)	0.7	81.5	4.4	10.6	0.4	0.3	2.1
296	25 M.W. (2)	1.5	55.6	0.0	37.1	1.5	0.0	4.2
288-5	2885	22.0	59.7	6.8	6.0	0.3	0.0	0.3

---

[1] Values represent percent of bulk minerals.

around platform B and less in the winter than in summer samples (Tables 3.2.12 and 3.2.13). There also appears to be a greater percentage of illite and kaolinite in the winter sediments than in the summer sediments. Sediments taken below the discharge and below the flare stack do not appear drastically different in composition than those around the platform. Figures 3.2.15 through 3.2.26 show contours of clay minerals around the platforms.

3.2.4.c Clay Mineralogy Comparison with Data from the Central Gulf Platform Study

Clay mineralogy was also determined around production platforms as part of the Bureau of Land Management Central Gulf Platform Study (Huang, 1980). Clay mineralogy on suspended particulates was not undertaken as part of the above study. However, sediments for clay analysis were taken around 24 different platforms on 2 different cruises. The clay minerals in the studied area are, in general, consistent with those in the Central Gulf Platform. That is, generally, smectite is by far greater than kaolinite and illite.

3.2.5 Clay Mineralogy, Organic Carbon, and Carbonate Comparison and Seasonal Variations

As reported in section 3.2.3 of this report, organic carbon contour gradient decreases away from the platforms. This is generally true with the expandable clay smectite. High percentages of smectite occur at or near the platform. The presence of organic matter is known to promote the formation of expandable

Table 3.2.12

CLAY MINERALOGY IN SEDIMENTS, SUMMER, 1978

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]
288	10 M.N.	45.0	35.0	20.0
288	25 M.N	37.0	25.0	38.0
288	50 M.N.	37.0	28.0	35.0
288	10 M.E.	50.0	23.0	27.0
288	25 M.E.	55.0	21.0	24.0
288	50 M.E.	39.0	29.0	32.0
288	10 M.S.	69.0	17.0	14.0
288	25 M.S.	48.0	24.0	28.0
288	50 M.S.	66.0	16.0	18.0
288	10 M.W.	51.0	23.0	26.0
288	25 M.W.	57.0	17.0	26.0
288	50 M.W.	46.0	36.0	18.0
288	288WJ	54.0	26.0	20.0
288	2880	61.0	23.0	16.0
296	10 M.N.	52.0	26.0	22.0
296	25 M.N.	46.0	36.0	18.0
296	50 M.N.	51.0	22.0	27.0
296	10 M.E.	67.0	15.0	18.0
296	25 M.E.	53.0	27.0	20.0
296	50 M.E.	72.0	14.0	14.0
296	10 M.S.	61.0	16.0	23.0
296	25 M.S.	71.0	15.0	14.0
296	50 M.S.	57.0	21.0	22.0
296	10 M.W.	78.0	11.0	11.0
296	25 M.W.	62.0	25.0	13.0
296	50 M.W.	65.0	19.0	17.0
296	0	49.0	30.0	21.0
296	296-FS	56.0	27.0	17.0

[1] Values represent percent of clay minerals.

Table 3.2.13

CLAY MINERALOGY IN SEDIMENTS, WINTER, 1978

Station	Location	Smectite[1]	Illite[1]	Kaolinite[1]
288	10 M.N.	39.5	40.1	20.4
288	25 M.N.	49.2	25.8	25.0
288	50 M.N.	38.5	27.2	34.3
288	10 M.E.	35.2	29.0	35.8
288	25 M.E	22.9	45.1	32.0
288	50 M.E.	39.9	29.2	30.9
288	10 M.S.	32.2	35.0	32.8
288	25 M.S.	44.6	27.7	27.7
288	50 M.S.	33.8	32.4	33.8
288	10 M.W.	23.0	50.6	26.4
288	25 M.W.	32.9	30.1	37.0
288	50 M.W.	45.4	28.2	26.4
288	Discharge	33.5	34.8	31.7
296	10 M.N.	34.1	38.1	27.8
296	25 M.N.	53.4	22.5	24.1
296	50 M.N.	36.0	35.4	28.6
296	10 M.E.	34.9	36.2	28.9
296	25 M.E.	31.6	36.8	31.6
296	50 M.E.	52.9	25.5	21.6
296	10 M.S.	27.9	44.8	27.3
296	25 M.S.	34.4	37.4	28.2
296	50 M.S. (1)	41.2	29.4	29.4
296	10 M.W.	26.3	41.5	32.2
296	25 M.W. (1)	52.8	26.4	20.8
296	50 M.W	39.9	36.3	23.8
296	Discharge	45.2	29.4	25.4
296	Flair	46.3	28.6	25.1
296	50 M.S. (2)	33.8	34.4	26.8
296	25 M.W. (2)	45.3	29.9	24.8
288-5	2885	27.9	33.0	39.1

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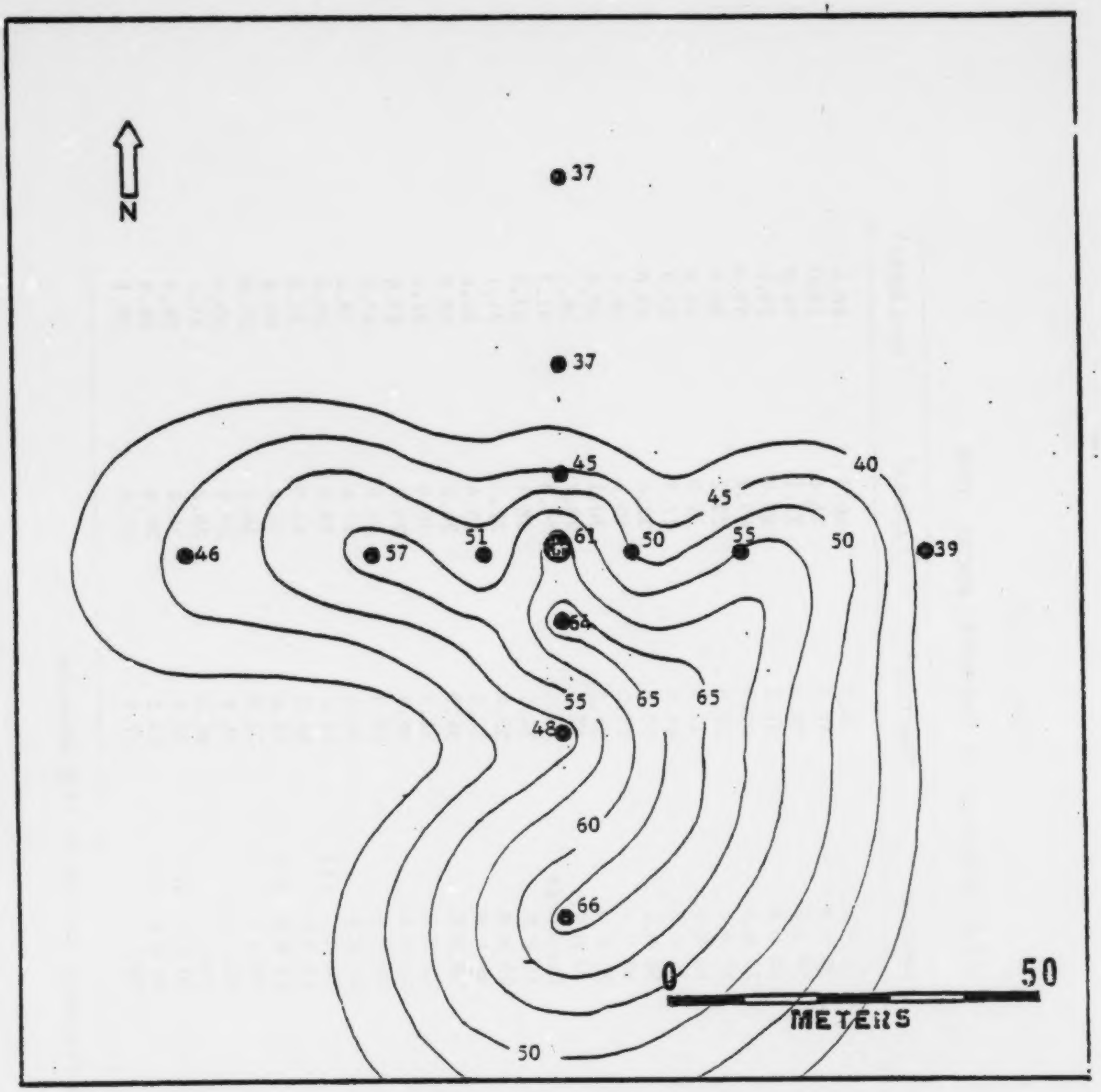
[1] Values represent percent of clay minerals.


N
37
37
45
40
45
46
57
51
61
50
55
50
39
64
55
65
65
48
60
66
50
0
50
METERS

PLATFORM	●	SITE	288
SAMPLING SITE	●	CLAY	Smectite
CONTOUR LINE	-10%-	DATE	Summer

Figure 3.2.15 Smectite concentrations at Platform A during the summer sampling.

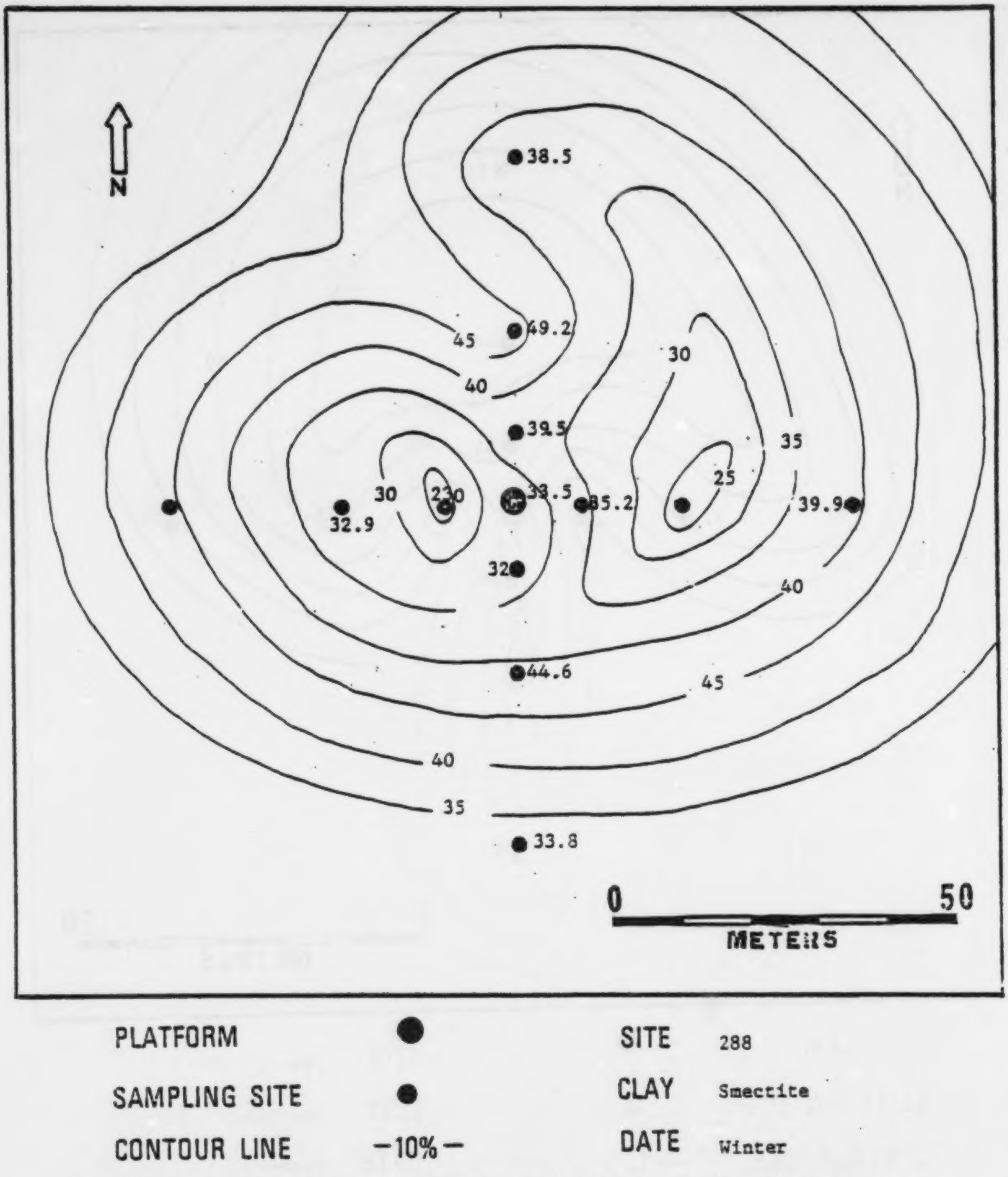
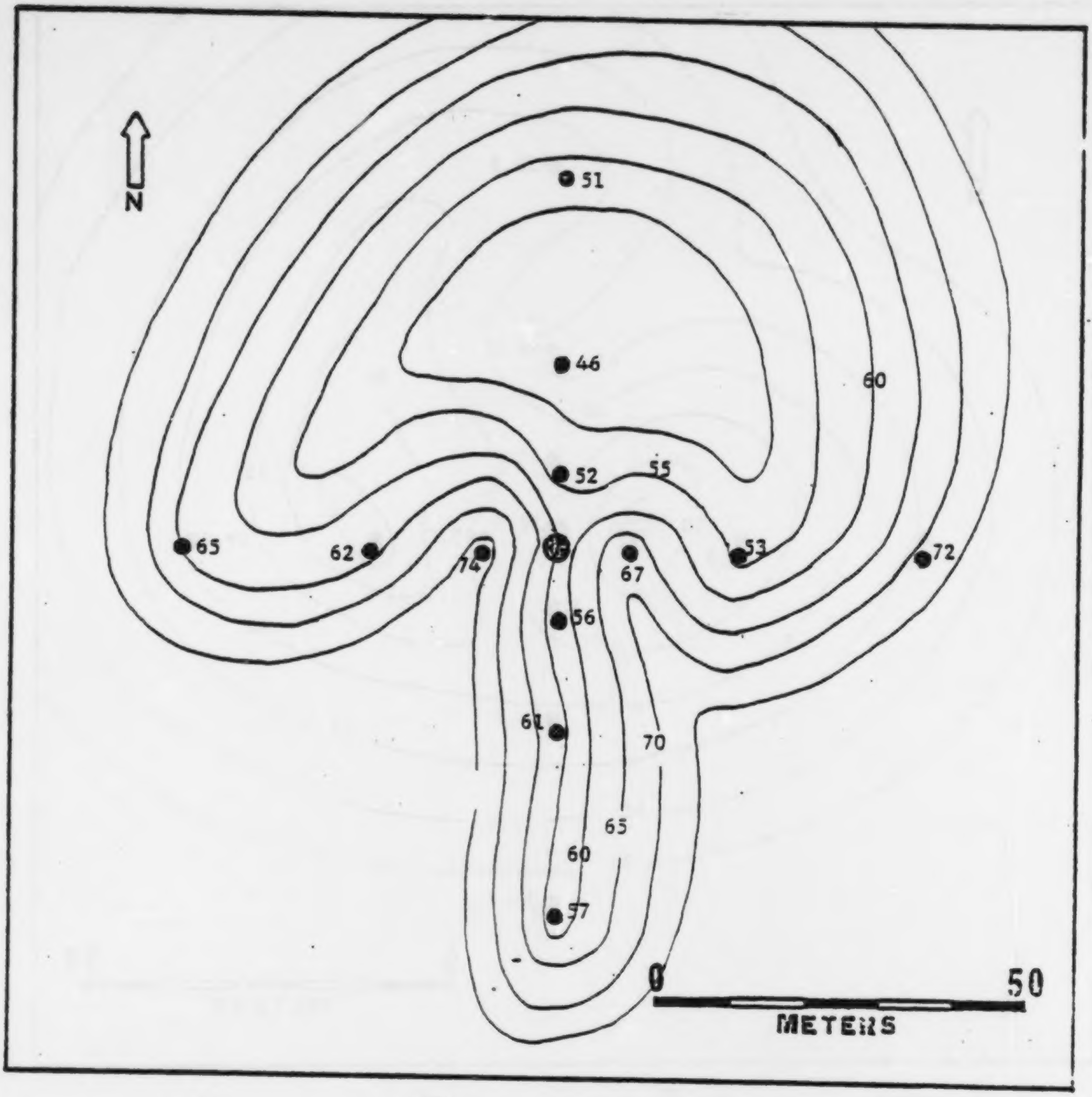

N
38.5
49.2
45
40
30
39.5
30
230
33.5
35.2
25
35
39.9
32.9
32
40
44.6
45
40
35
33.8
0
50
METERS
PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE —10%—
SITE 288
CLAY Smectite
DATE Winter

Figure 3.2.16 Smectite concentrations at Platform A during the winter sampling.


N
51
46
60
52
55
65
62
74
67
53
72
56
61
70
65
60
57
0
50
METERS

PLATFORM	●	SITE	296
SAMPLING SITE	●	CLAY	Smectite
CONTOUR LINE	– 10% –	DATE	Summer

Figure 3.2.17 Smectite concentrations at Platform B during the summer sampling.

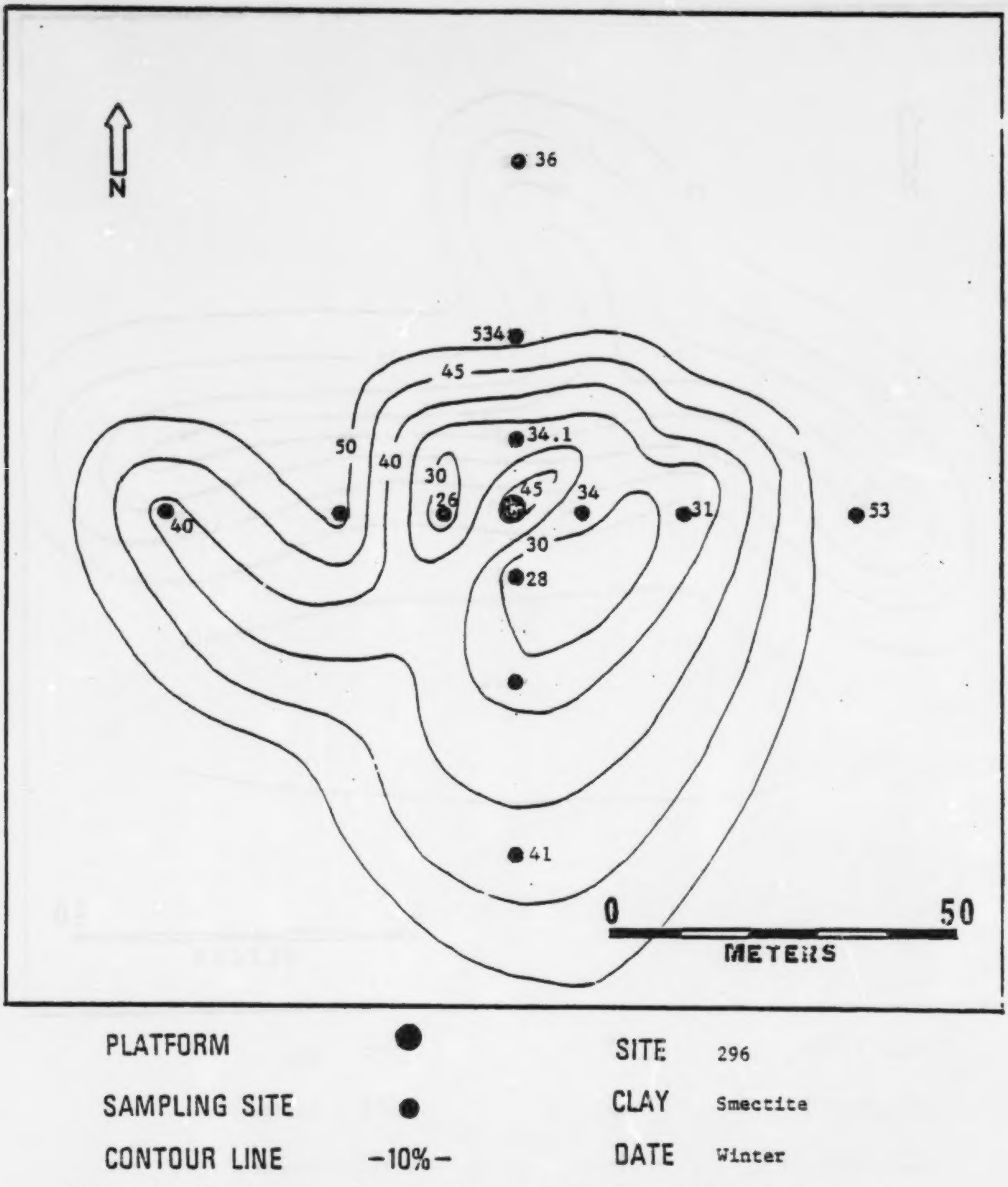
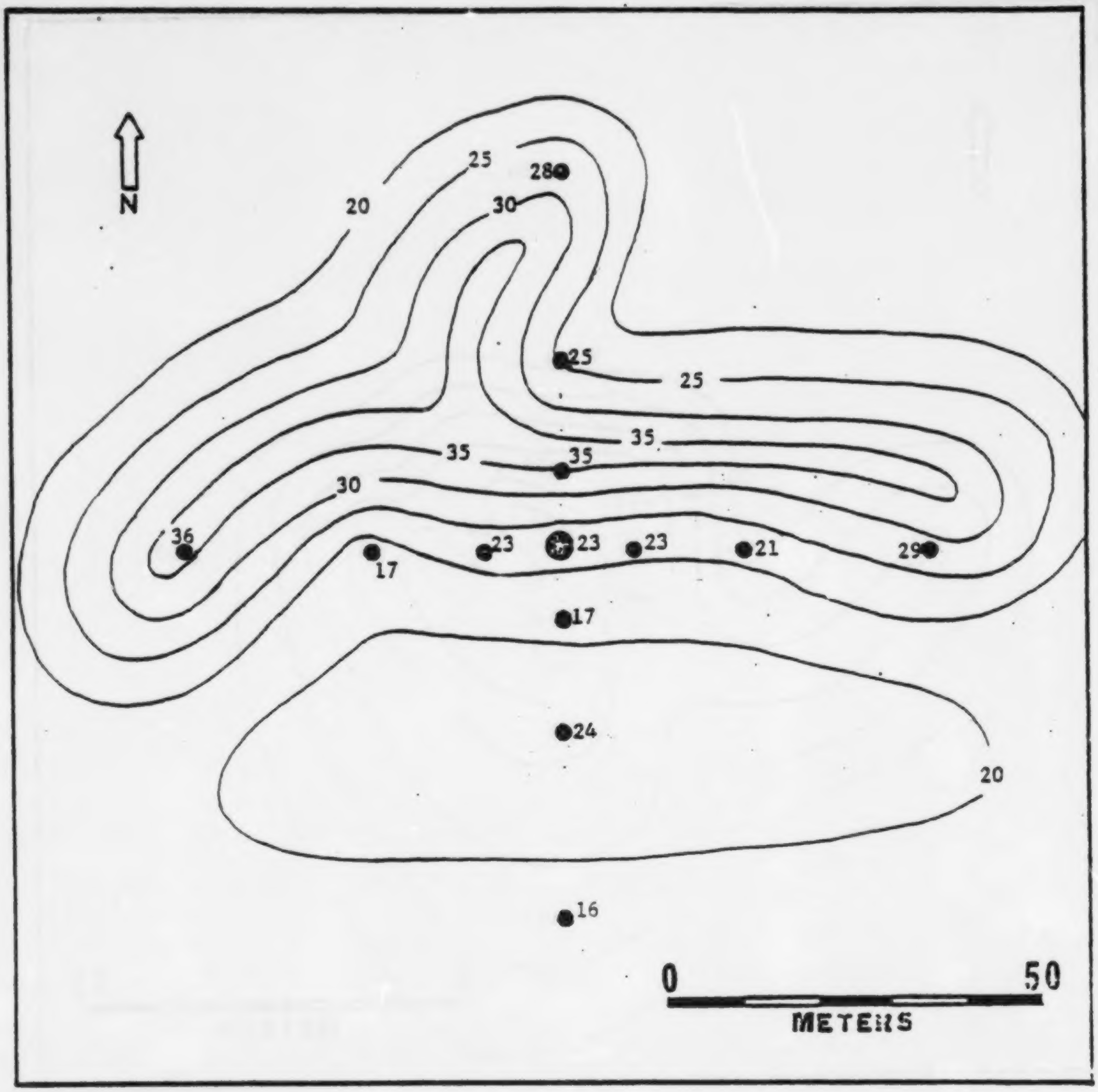

N
36
534
45
50
40
30
34.1
26
45
34
31
53
40
30
28
41
0
50
METERS
PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE -10%-
SITE 296
CLAY Smectite
DATE Winter

Figure 3.2.18 Smectite concentrations at Platform B during the winter sampling.

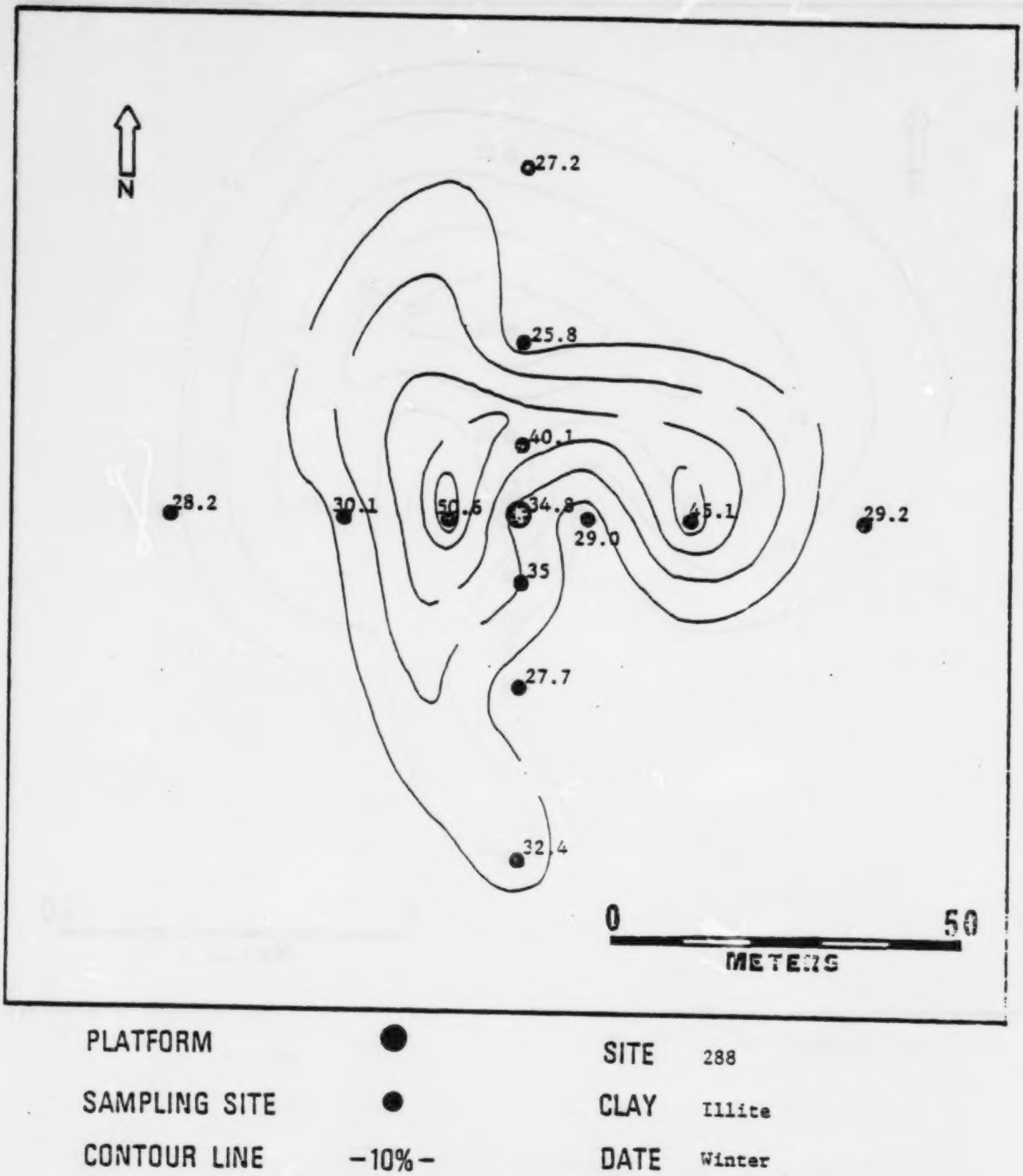

N
25
28
20
30
25
25
35
35
35
30
36
17
23
23
23
21
29
17
24
20
16
0
50
METERS

PLATFORM ● **SITE** 288

SAMPLING SITE ● **CLAY** Illite

CONTOUR LINE −10%− **DATE** Summer

Figure 3.2.19 Illite concentrations at Platform A during the summer sampling.


N
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25.8
40.1
28.2
30.1
50.6
34.8
29.0
45.1
29.2
35
27.7
32.4
0
50
METERS
PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE -10%-
SITE 288
CLAY Illite
DATE Winter

Figure 3.2.20 Illite concentrations at Platform A during the winter sampling.

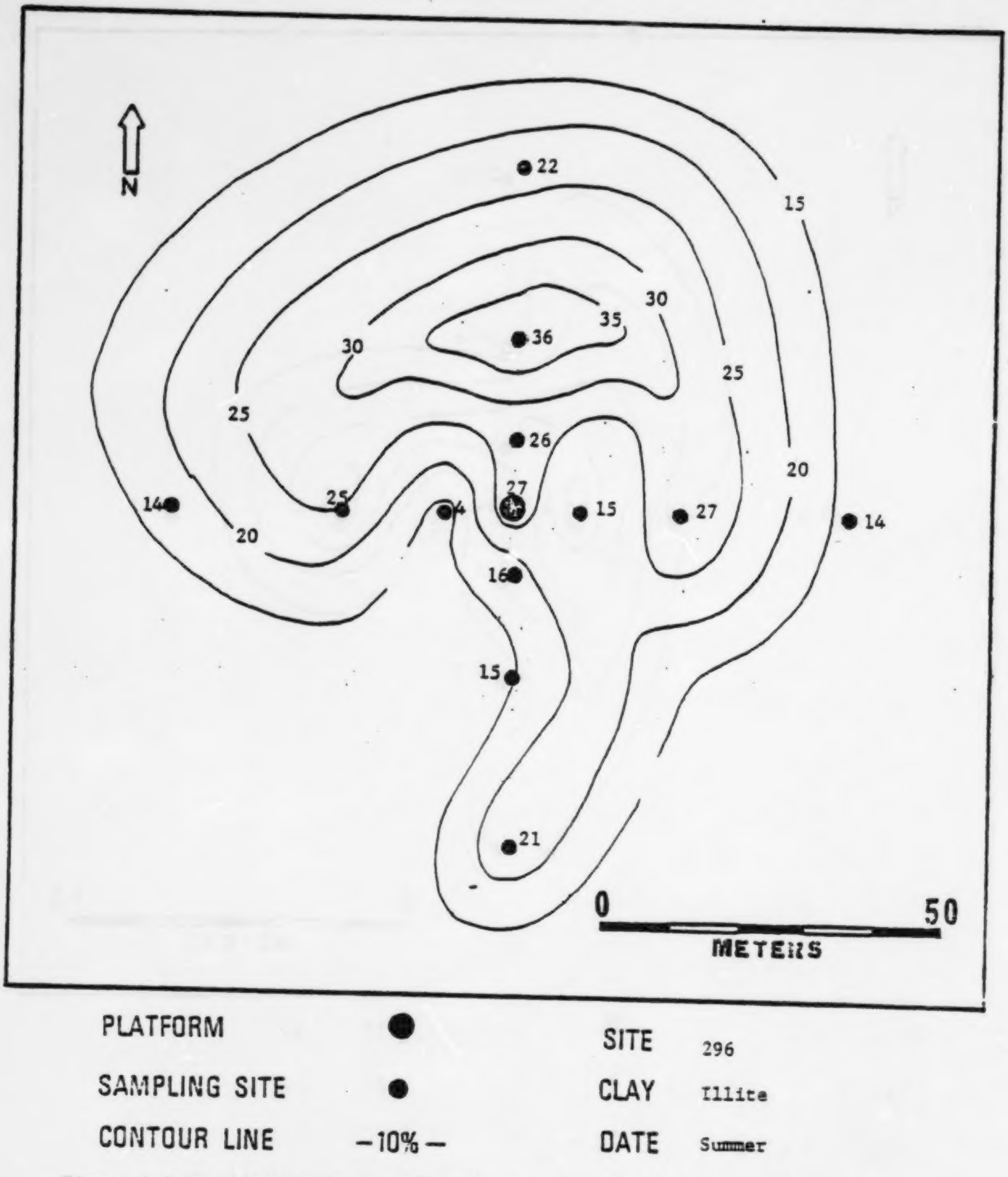
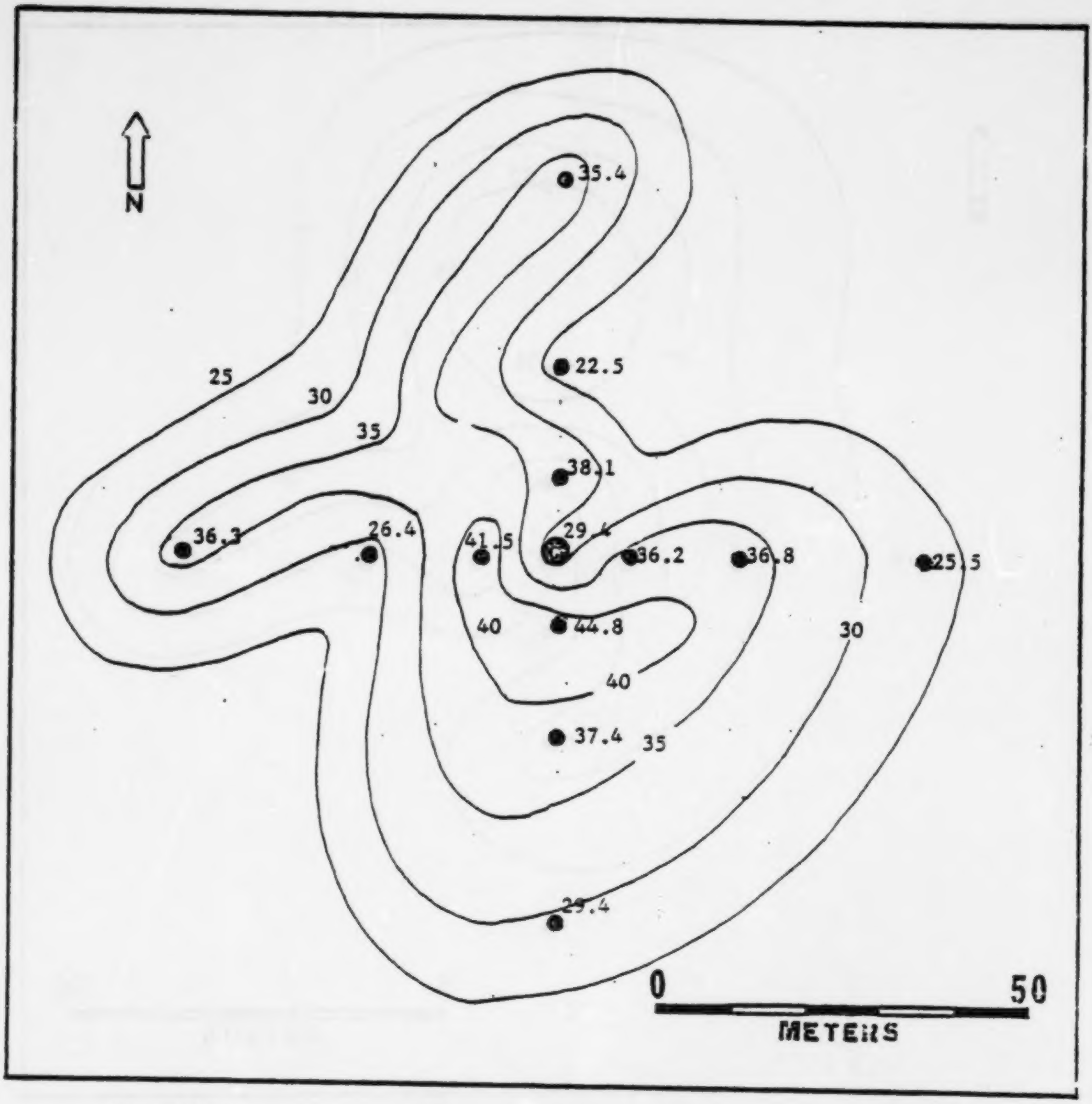
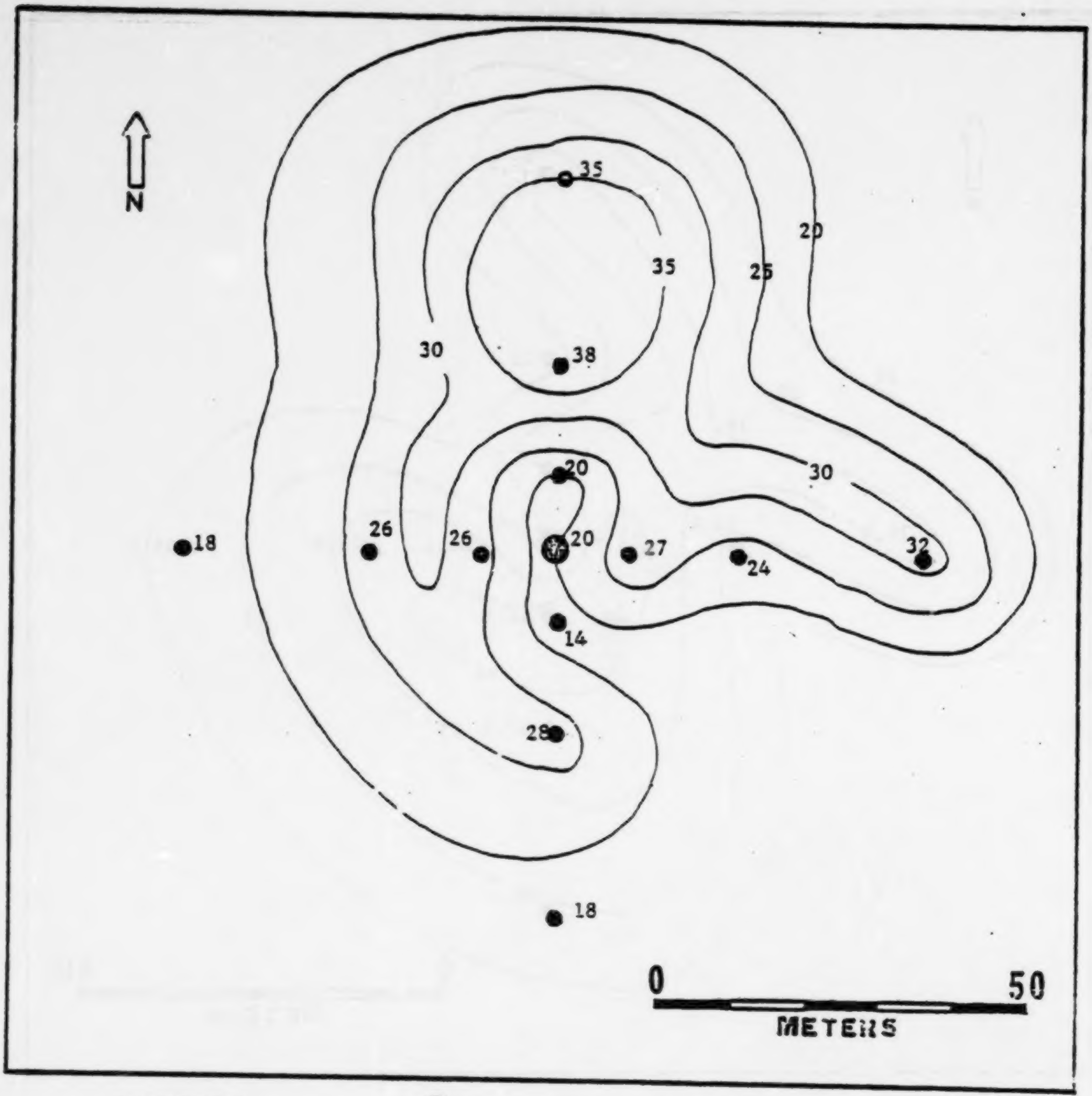

N
22
15
30
35
36
30
25
25
26
27
25
14
20
4
15
27
20
14
16
15
21
0
50
METERS
PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE —10%—
SITE 296
CLAY Illite
DATE Summer

Figure 3.2.21 Illite concentrations at Platform B during the summer sampling.


N
35.4
22.5
25
30
35
38.1
36.3
26.4
41.5
29.4
36.2
36.8
25.5
40
44.8
30
40
37.4
35
29.4
0
50
METERS

PLATFORM	●	SITE	296
SAMPLING SITE	●	CLAY	Illite
CONTOUR LINE	– 10% –	DATE	Winter

Figure 3.2.22 Illite concentrations at Platform B during the winter sampling.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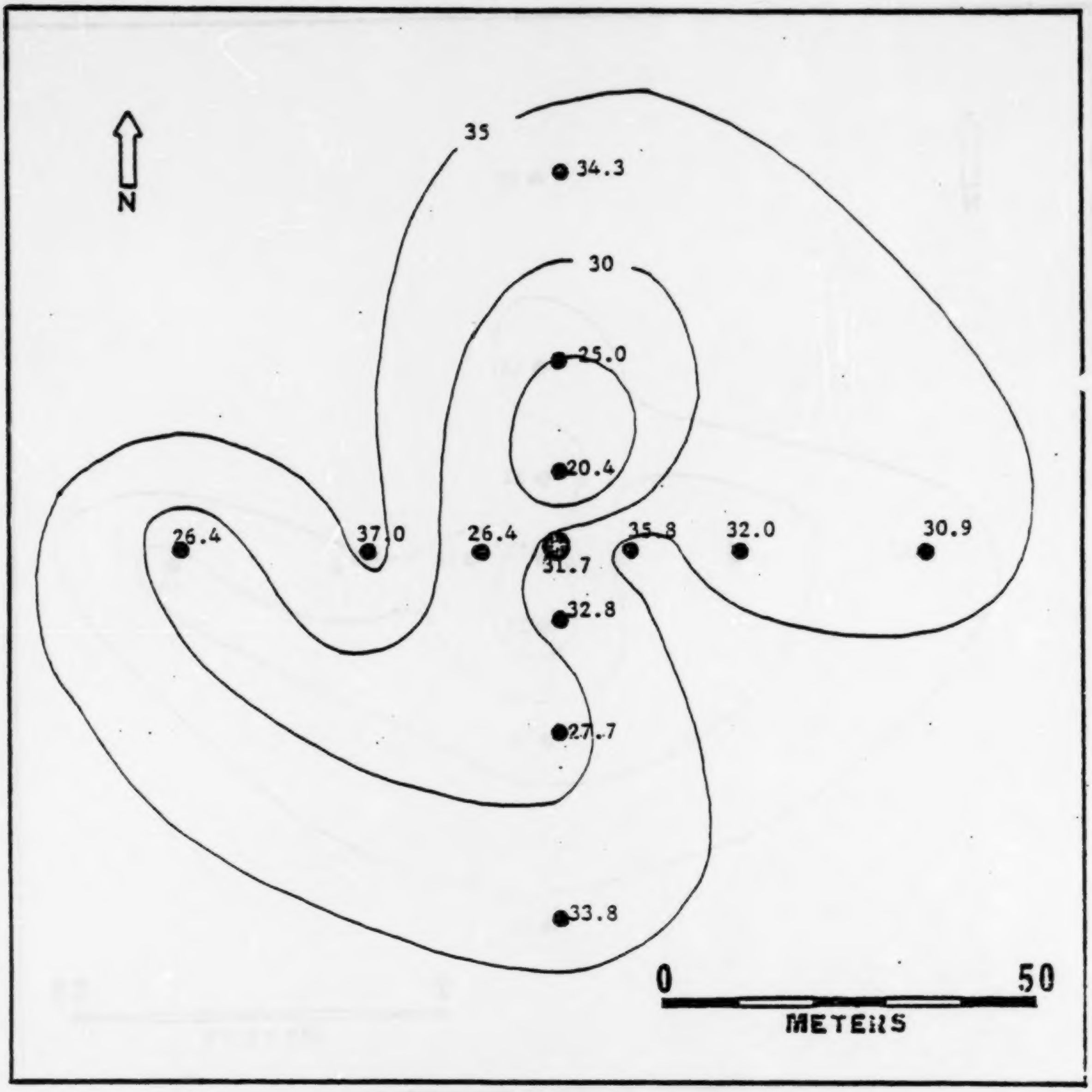
35
35
20
25
30
38
30
20
30
18
26
26
20
27
24
32
14
28
18
0
50
METERS

PLATFORM	●	SITE	288
SAMPLING SITE	●	CLAY	Kaolinite
CONTOUR LINE	—10%—	DATE	Summer

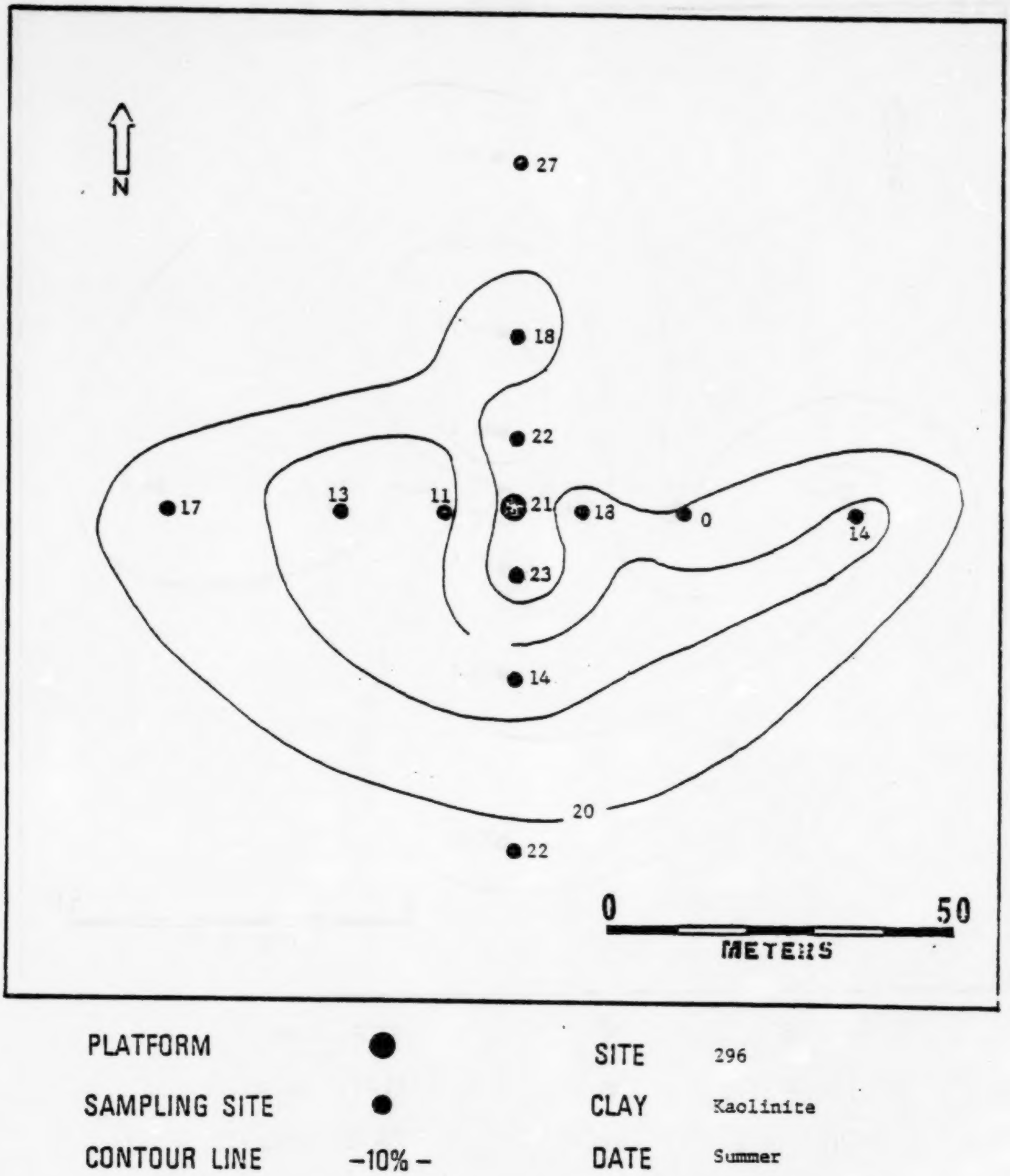
Figure 3.2.23 Kaolinite concentrations at Platform A during the summer sampling.


N
35
30
34.3
25.0
20.4
26.4
37.0
26.4
31.7
35.8
32.0
30.9
32.8
27.7
33.8
0
50
METERS

PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE —10%—

SITE 288
CLAY Kaolinite
DATE Winter

Figure 3.2.24 Kaolinite concentrations at Platform A during the winter sampling.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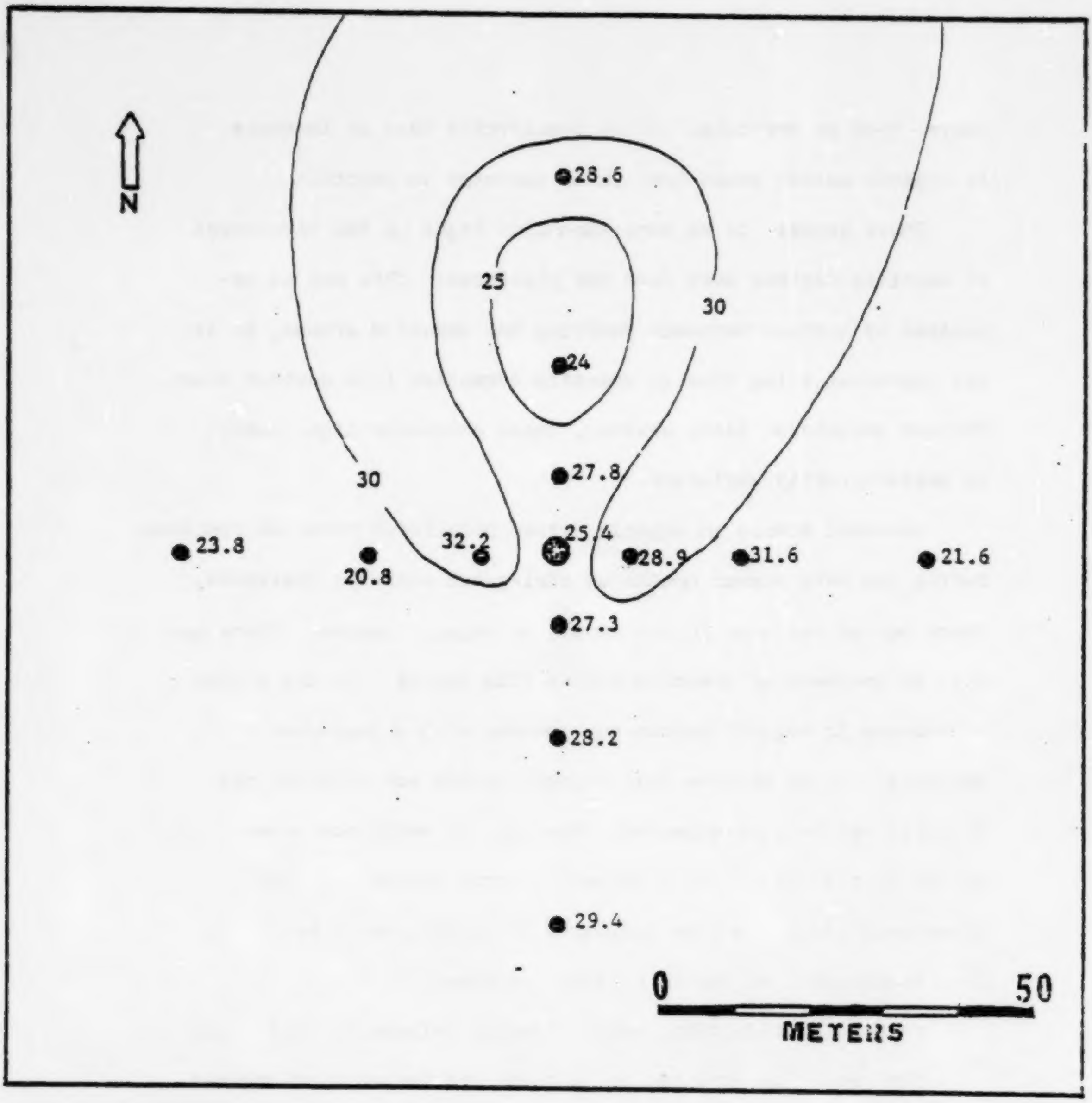
METERS
PLATFORM ●
SAMPLING SITE ●
CONTOUR LINE −10%−
SITE 296
CLAY Kaolinite
DATE Summer

Figure 3.2.25 Kaolinite concentrations at Platform B during the summer sampling.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27.3
28.2
29.4
0
50
METERS

PLATFORM	●	SITE	296
SAMPLING SITE	●	CLAY	Kaolinite
CONTOUR LINE	—10%—	DATE	Winter

Figure 3.2.26 Kaolinite concentrations at Platform B during the winter sampling.

clays, such as smectite. It is conceivable that an increase in organic matter would lead to an increase in smectite.

There appear to be some anomalous highs in the percentage of smectite farther away from the platforms. This may be explained by current movement shifting the smectite around, or it may represent a lag time in smectite formation from another clay. Without additional data, however, these anomalous highs cannot be satisfactorily explained.

Seasonal trends in organic carbon paralleled those of smectite. During the warm summer months as biological activity increases, there was an increase in the amount of organic carbon. There was also an increase of smectite during this period. In the winter a decrease in organic carbon was matched with a decrease in smectite. It is obvious that organic carbon and smectite are directly related, as expected. However, it would not be expected that a relationship between organic carbon and non-expandable clays, such as kaolinite or illite, would be found. Upon examination of the data, none was found.

Carbonate production, being directly related to biological activity, would be expected to increase and decrease as organic carbon does. However, carbonate does not relate to the amount of smectite, unlike the organic carbon.

4. CONCLUSIONS

Water column samples were taken at 12 stations (2, 5, 50, and 100 meters on north, east, south and west transects) around the two production platforms, and also near a well jacket and flare stack at Buccaneer Field during summer, fall, winter and spring periods. Characterization of the suspended particulates at these stations involved TSM, POC, chlorophyll, ATP, $CaCO_3$, silicate, carbon isotopes, particle size, clay mineralogy analyses, and transmissometry. Nutrients and DOC were also determined. Surficial sediments were analyzed for organic carbon, $CaCO_3$, clay mineralogy, particle size and carbon isotopes. Pb-210 dating was performed on six cores from the field to estimate sedimentation rate.

Large seasonal variations in the suspended load of the water column were characteristic of the field. Near-bottom nepheloid layers were found during all samplings except winter. During the winter, very high concentrations of TSM were observed nearly uniformly throughout the water column. In the spring, a very large surface nepheloid layer was observed, probably resulting from freshwater runoff from coastal bays and estuaries. Mid-depth nepheloid layers were observed during the spring and fall. Seasonal changes in suspended content of the water column generally reflected changing current and mixing patterns.

The composition of the suspended particulates varied considerably over the sampling periods. Clay was the dominate component of the particulates during all seasons. The organic fraction of the suspended particulates consisted almost exclusively of cellular material (phytoplankton, zooplankton, and/or bacteria). Only during the winter and spring were significant concentrations of particulate non-cellular carbon observed. These higher levels probably reflected fresh water inputs. In all seasons except winter, the cellular material generally constituted 20-30 percent of the suspended particulates. In the winter, due to a dramatic increase in phytoplankton productivity, organic suspended particulates constituted almost 50% of the TSM. Almost all the POC during the winter sampling was phytoplankton. During other seasons, phytoplankton constituted only a minor fraction of the cellular material. The majority of the inorganic suspended particulates were in the 2-5 μm size range.

Higher productivity during the winter increased the dissolved organic concentrations in the water column by 50 percent. Most other DOC concentrations throughout the year were around 1.2 ± 0.2 mgC/L.

The sedimentation rate in the field based on Pb-210 dating appears to vary from 1.5 to 2.1 mm/yr in the northern part of the field and from 3.5 to 3.7 mm/yr in the southern portion of the field. The higher sedimentation rates in the offshore direction may reflect local current patterns or resuspension and deposition of sediments, due to flow characteristics around the platforms.

There was a distinct decreasing gradient in both organic and inorganic carbon in the sediment away from the platform. This, no doubt, reflects high productivity associated with platforms.

A general decrease in grain size away from both platforms was observed. Sediments were extremely poorly sorted to poorly sorted. Sorting increased away from the platforms. A scouring effect appears to have been present to the south and west of the platforms. Quartz is the predominate mineral, followed by carbonate. Smectite is the most abundant clay mineral.

The Buccaneer Field production platforms did not measurably alter the bulk composition of suspended particulates or biological activity (as measured by chlorophyll and ATP) in their immediate vacinity. These results were to be expected, considering the small volumes discharged by the platforms (i.e., from brine, oil spillage, etc.) compared against the large volume of water transported through the field. Pollutants introduced into the water column from the platforms could be rapidly transported out of the system either because of hydrographic conditions or perhaps by attachment to suspended particulates. Once out of the field, rapid dilution would obscure their presence and diminish their effect.

Although we did not obtain hydrographic information during these cruises, suspended particulate data indicated that the water column was stratified during all samplings except winter. During the summer and fall samplings, a strong pycnocline, resulting from temperature stratification, apparently existed in the field inhibiting transport of surface introduced contaminants to the bottom. The winter water column was throughly mixed due to strong turbulent activity. The water column was again well stratified during the spring sampling, apparently due to a surface fresh water lense characterized by high suspended particulate levels. The stratification of the water column during the majority of the year, no doubt, acts as a barrier against introduction of platform contaminants to the sediments near the platforms. Platform derived contaminants in the water are rapidly removed from the field.

Contaminants introduced to the sediments in the Buccaneer field may also be rapidly removed from the platform vacinity by suspension and redeposition. Surficial sediment data indicated that there is considerable movement of the fine grain material in the area. Direction of sediment transport appeared to be controlled by seasonal current patterns. The near-bottom nepheloid layer observed during all seasons also indicated that fine grained surficial sediments within the field were in a continual state of resuspension and reworking. Only contaminants associated with very coarse grained material would be expected to permanently remain in the field. These observations were confirmed by trace metal and hydrocarbon studies in the field which show seasonal contamination patterns.

5. LITERATURE CITED

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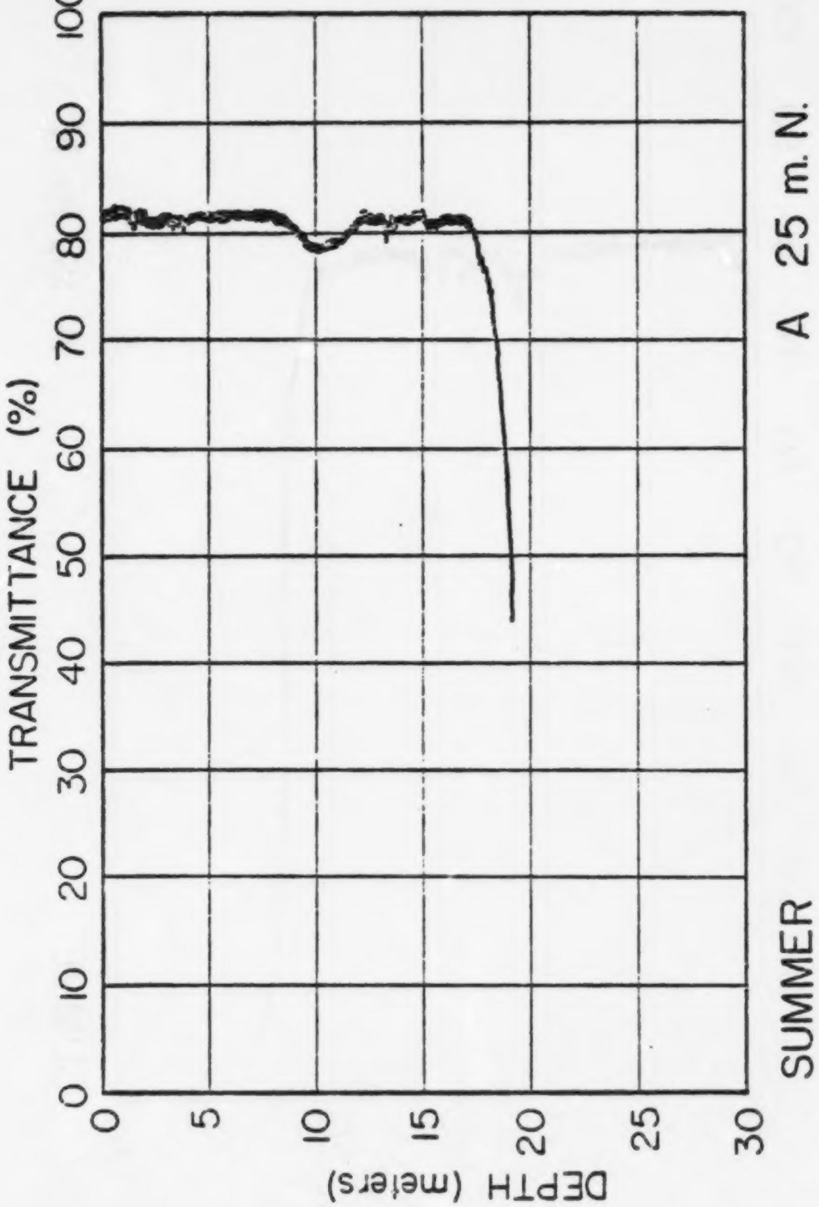
6.1. Seasonal Transmissometry Profiles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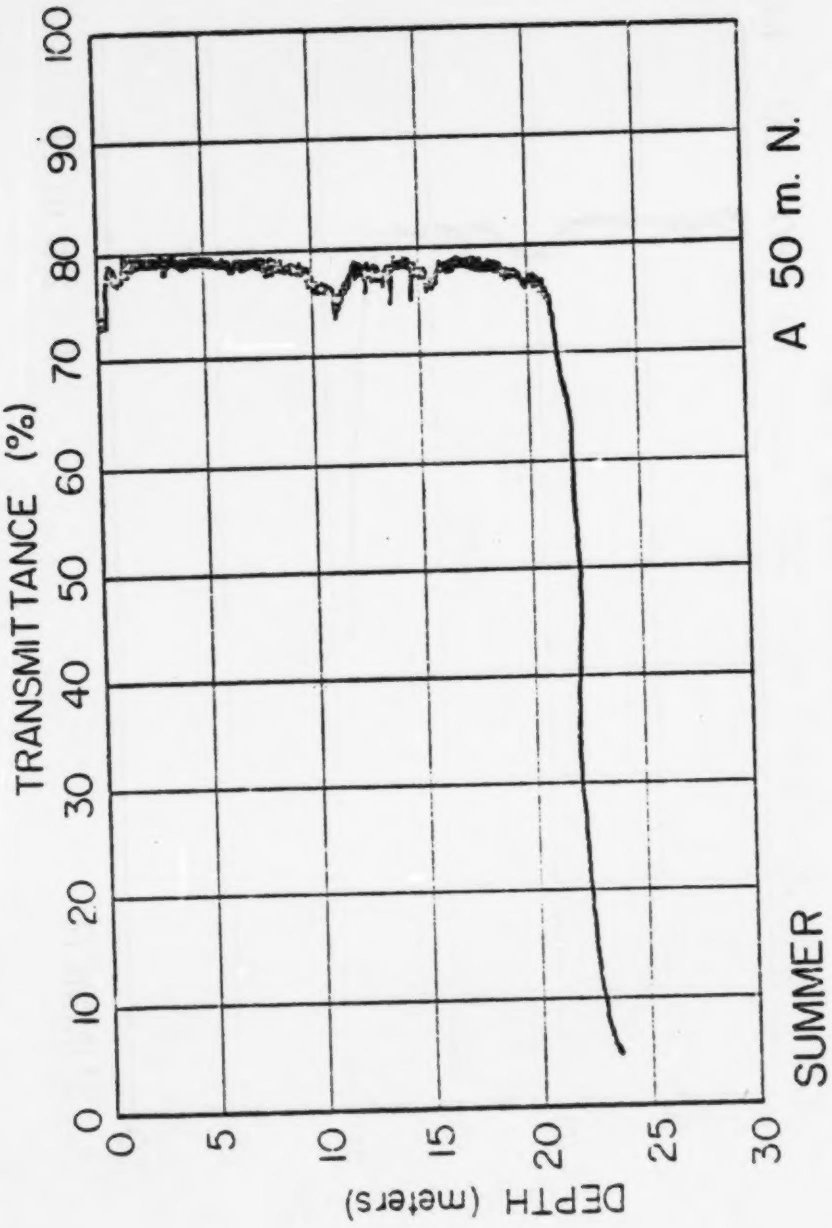
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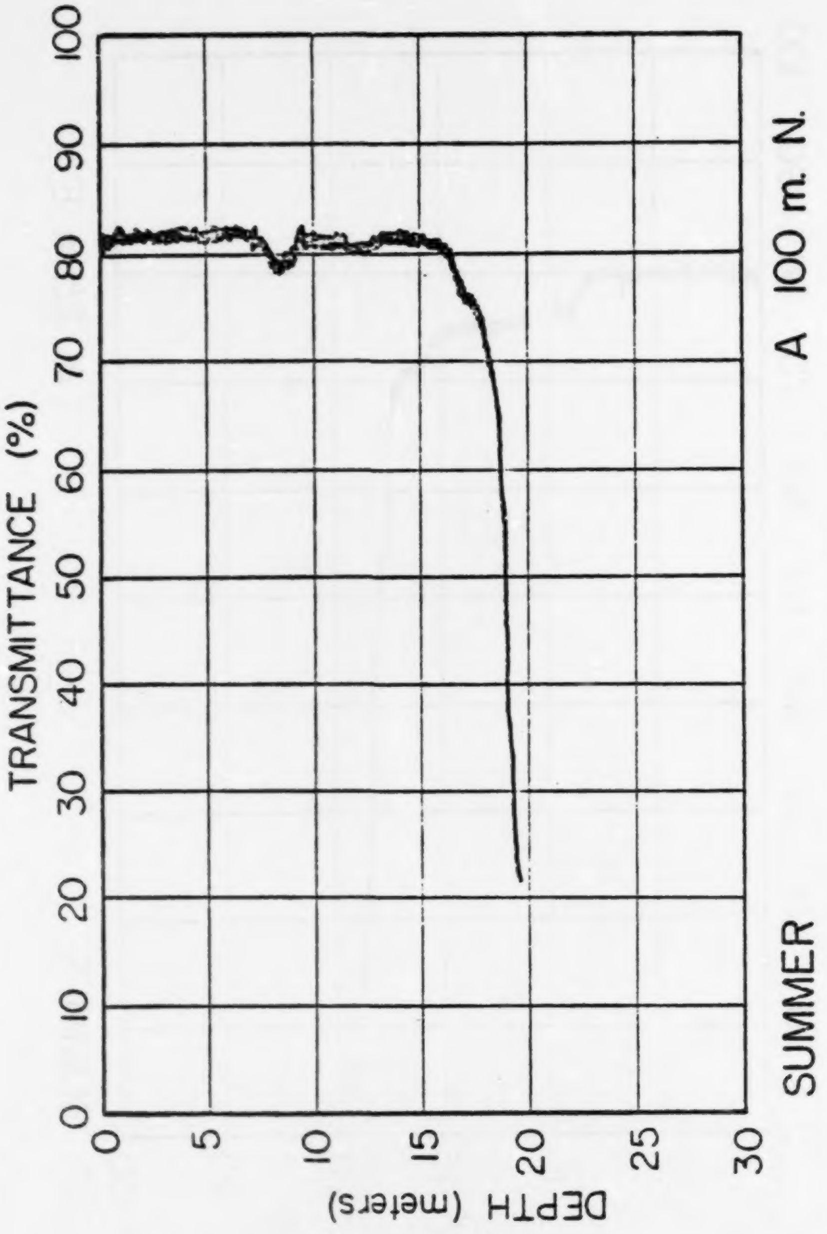
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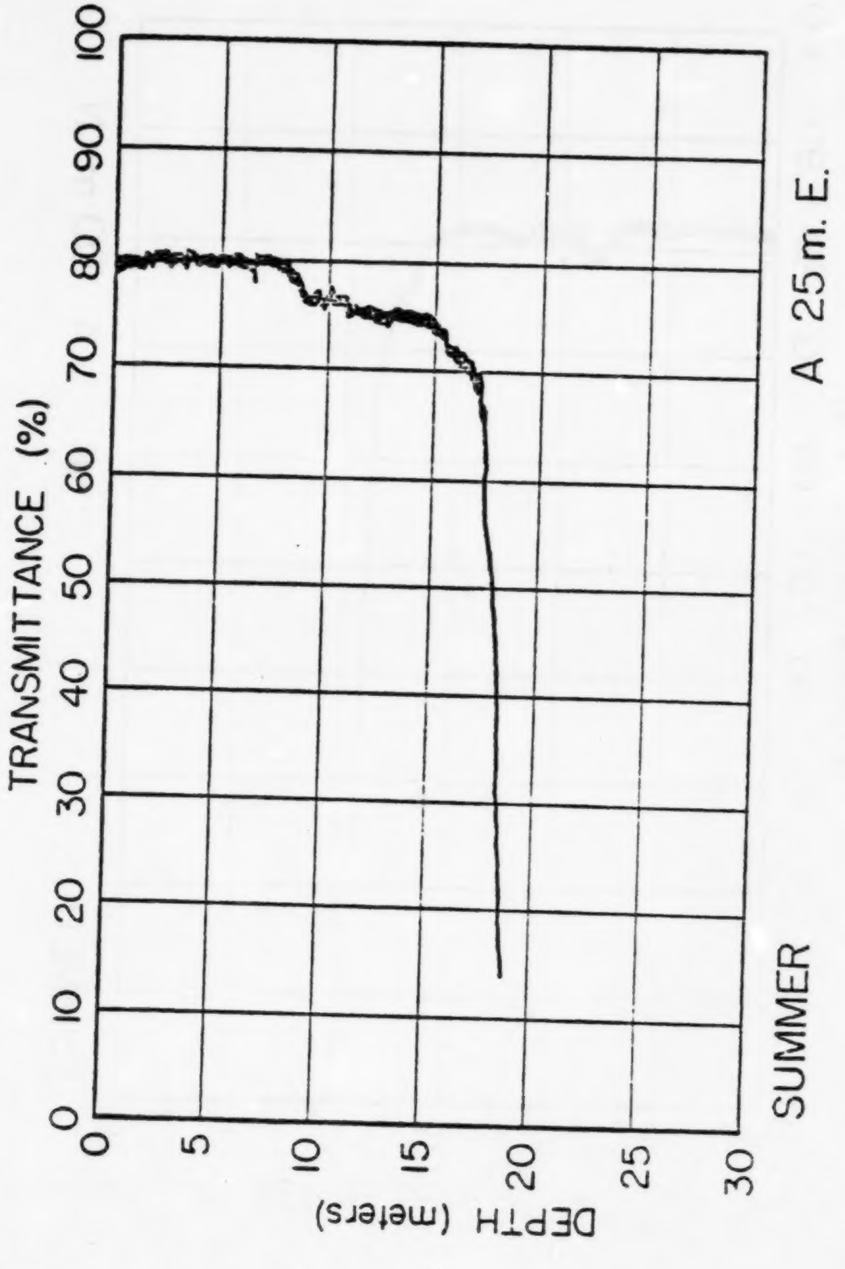
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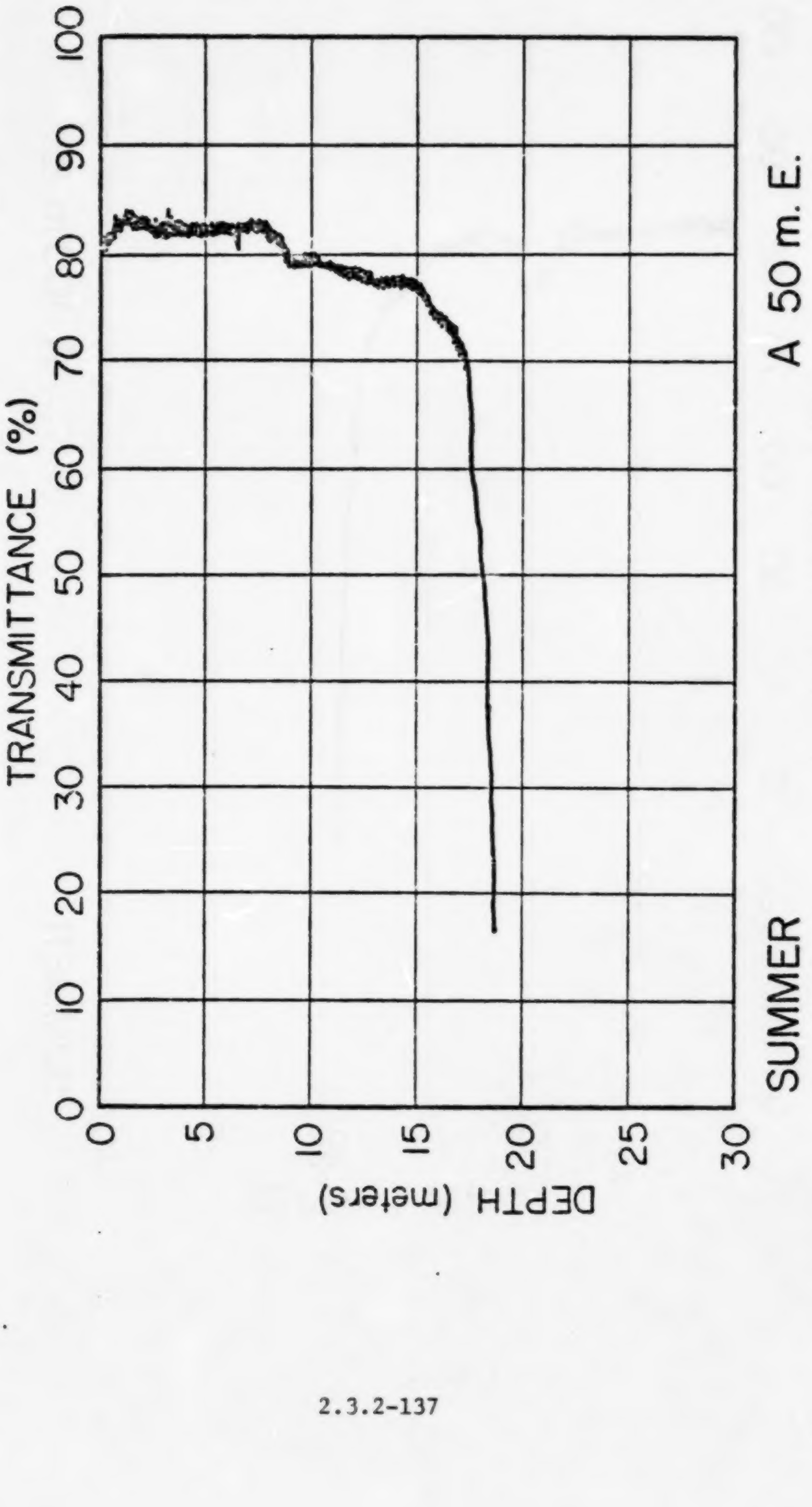
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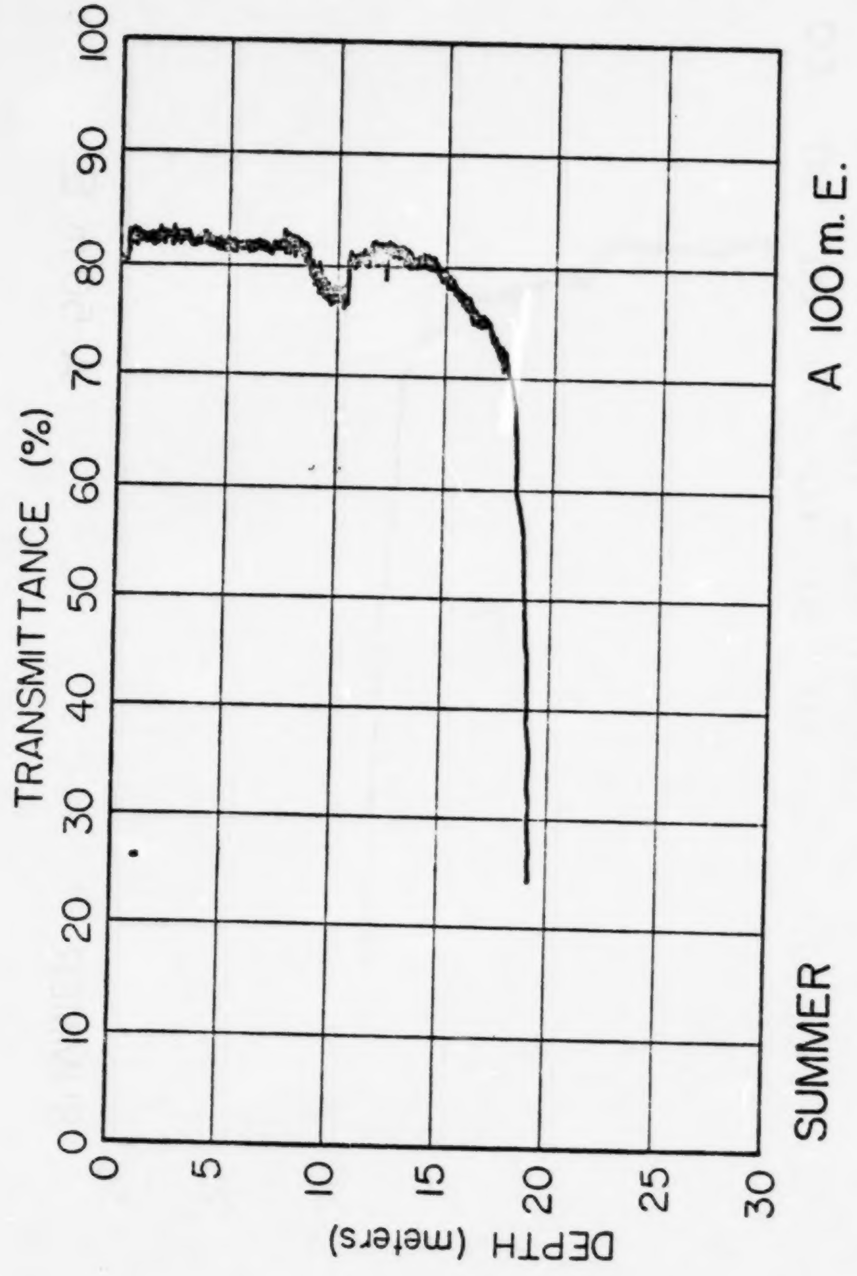
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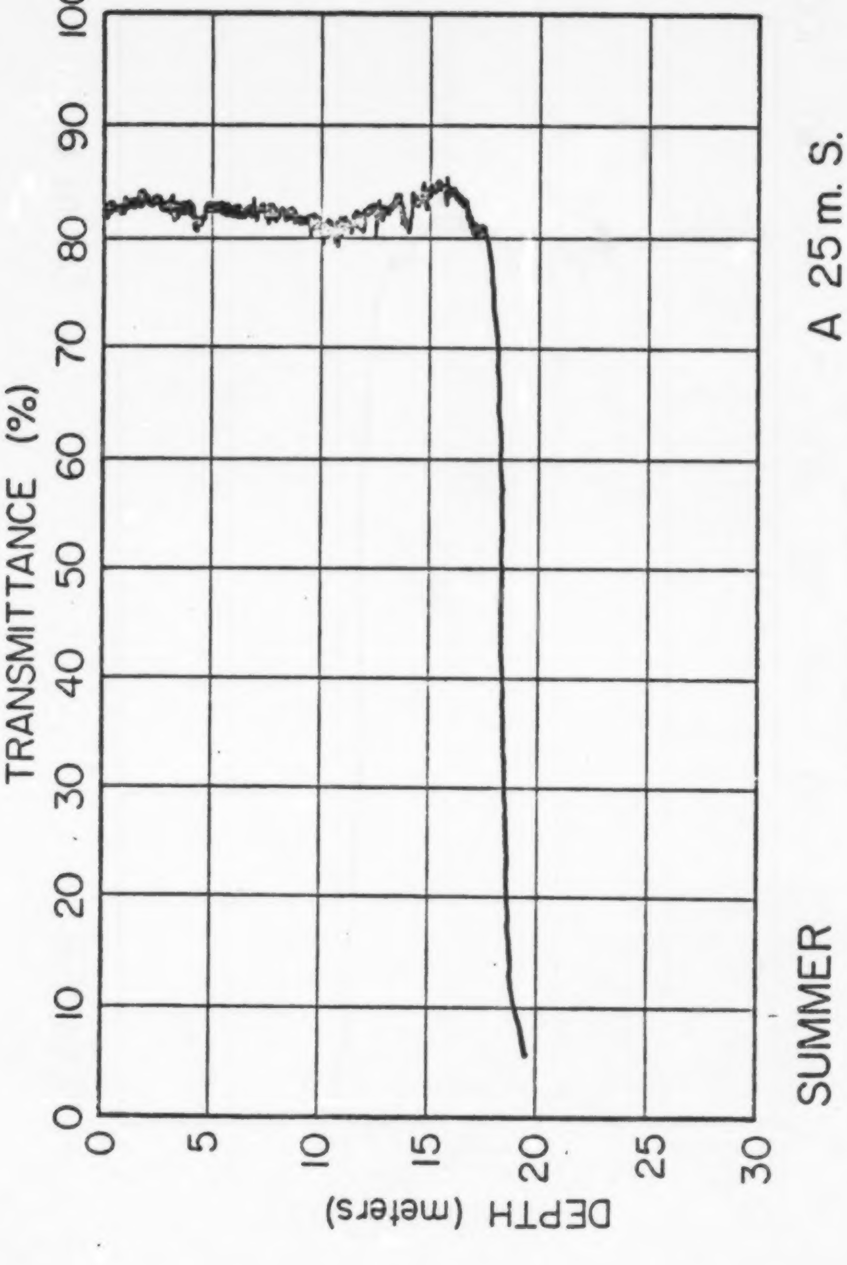
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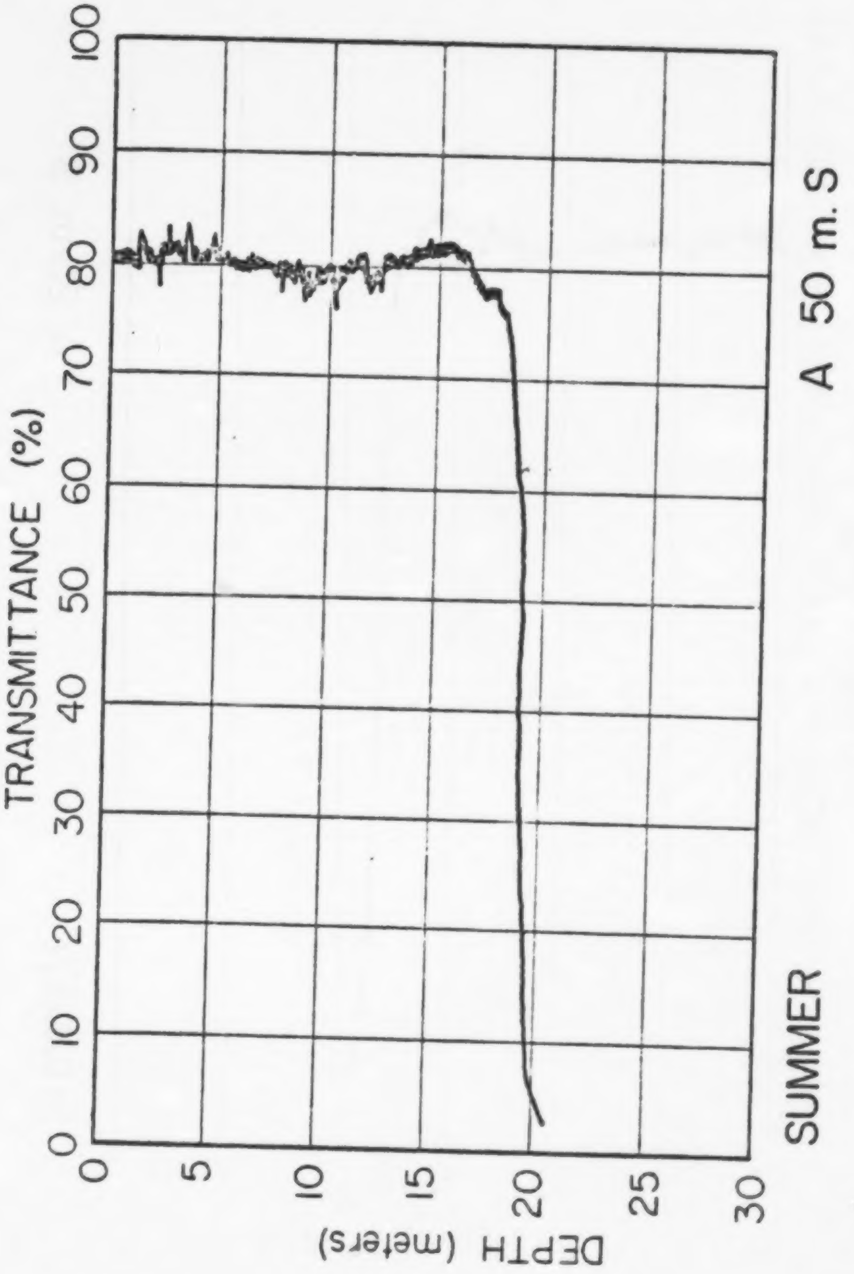
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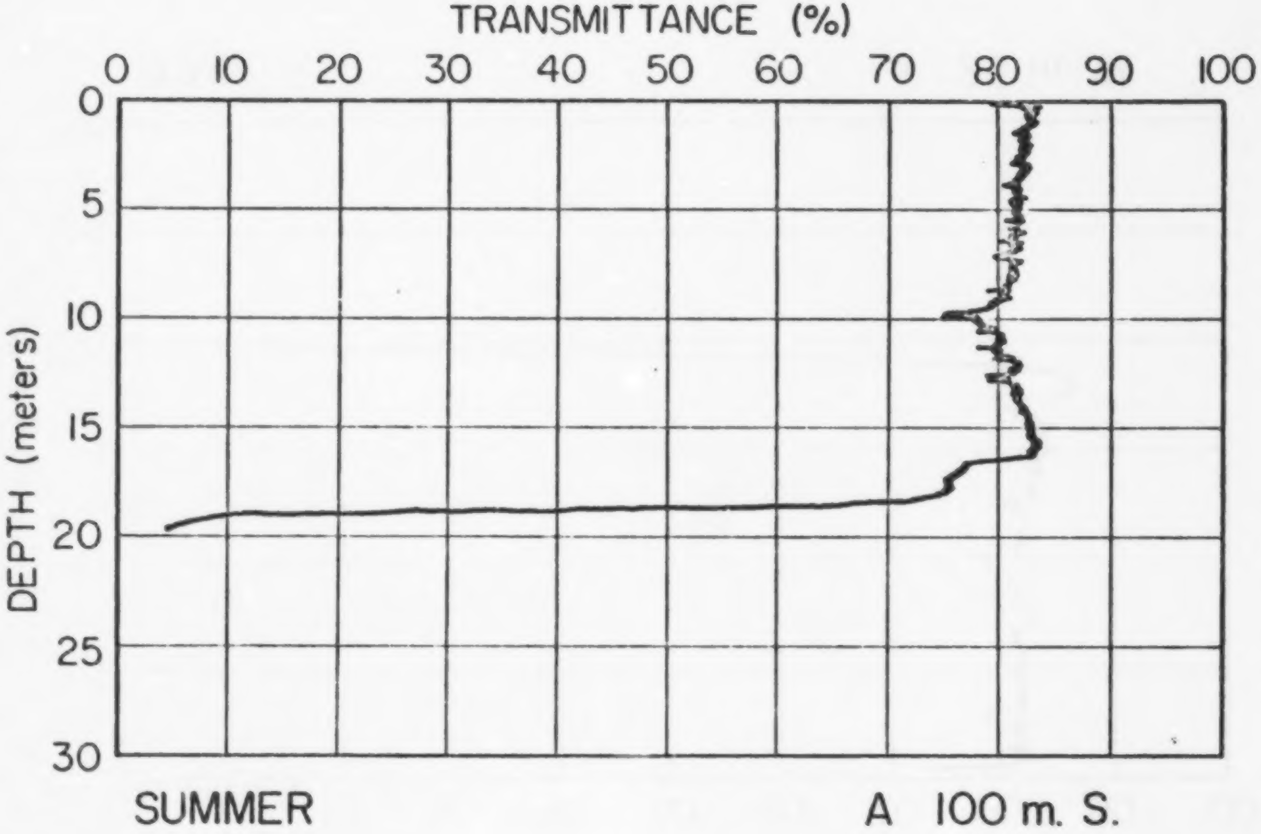
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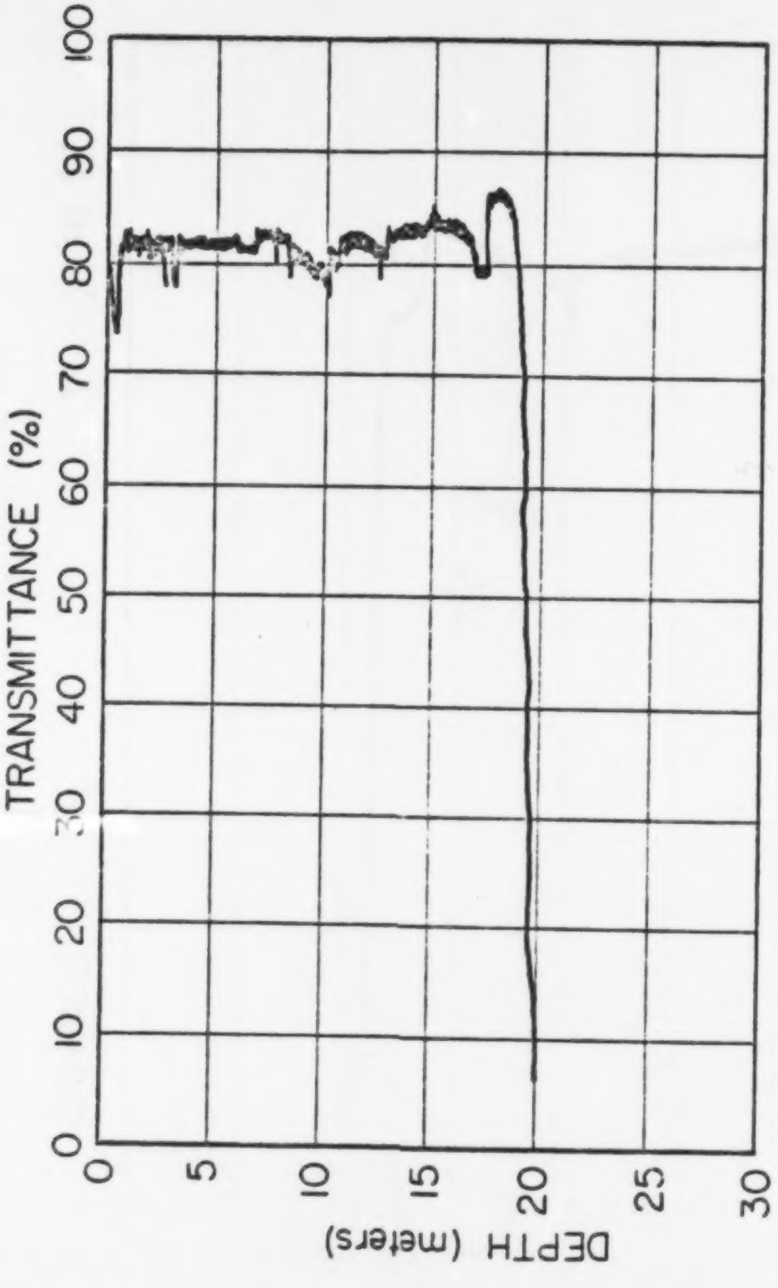

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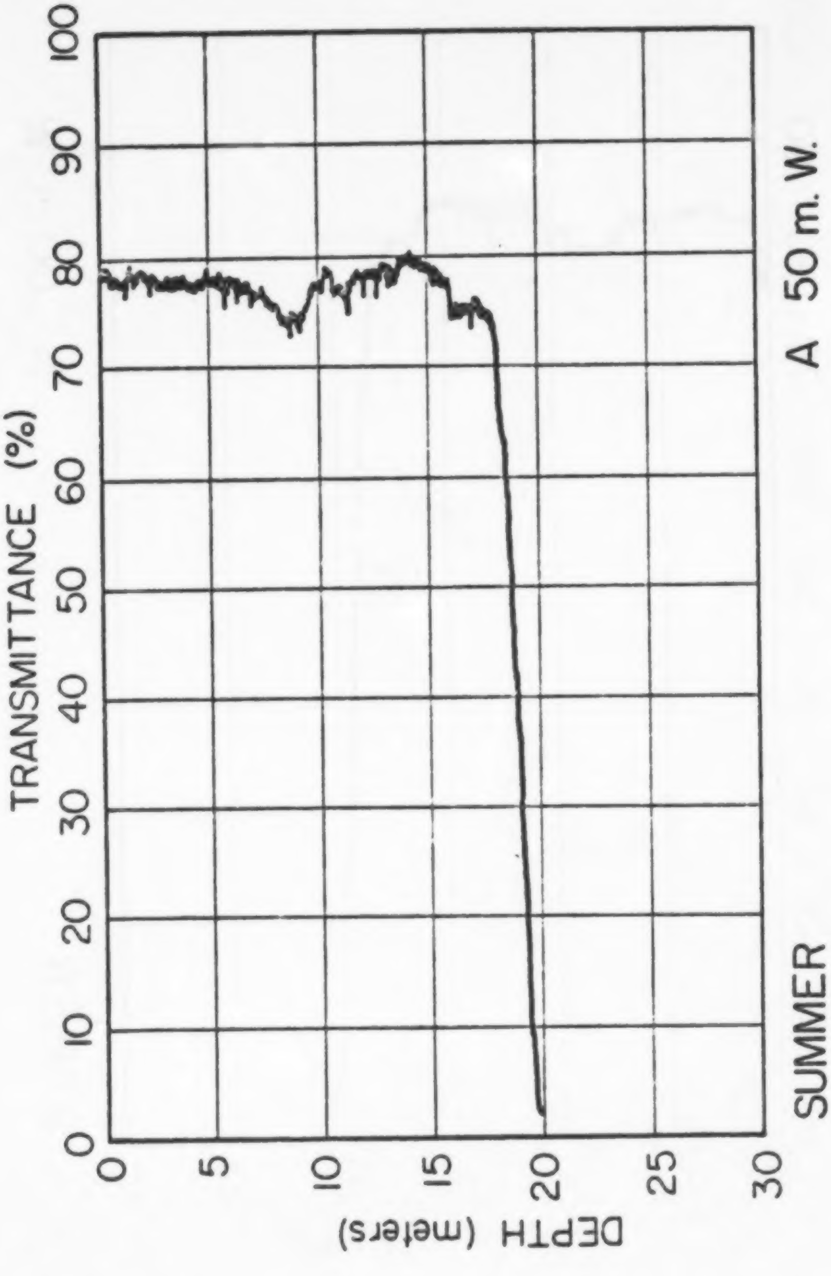
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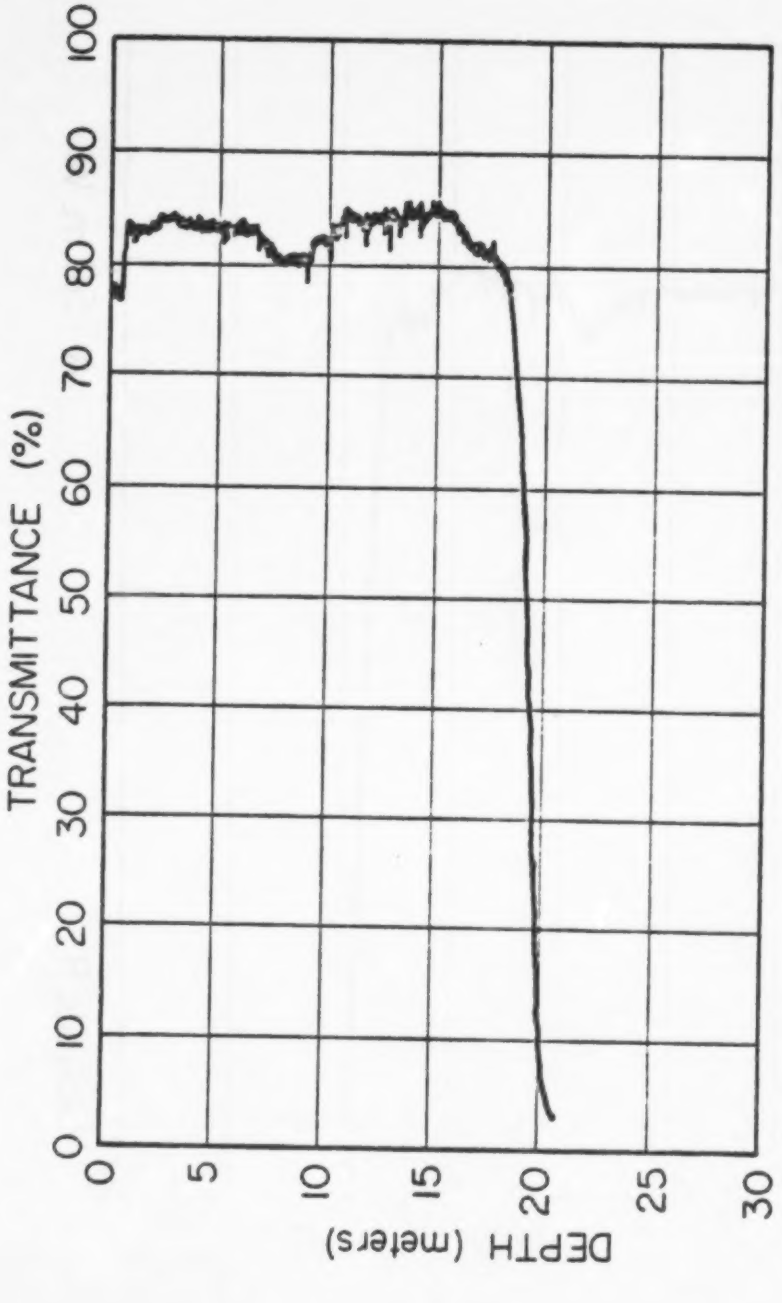

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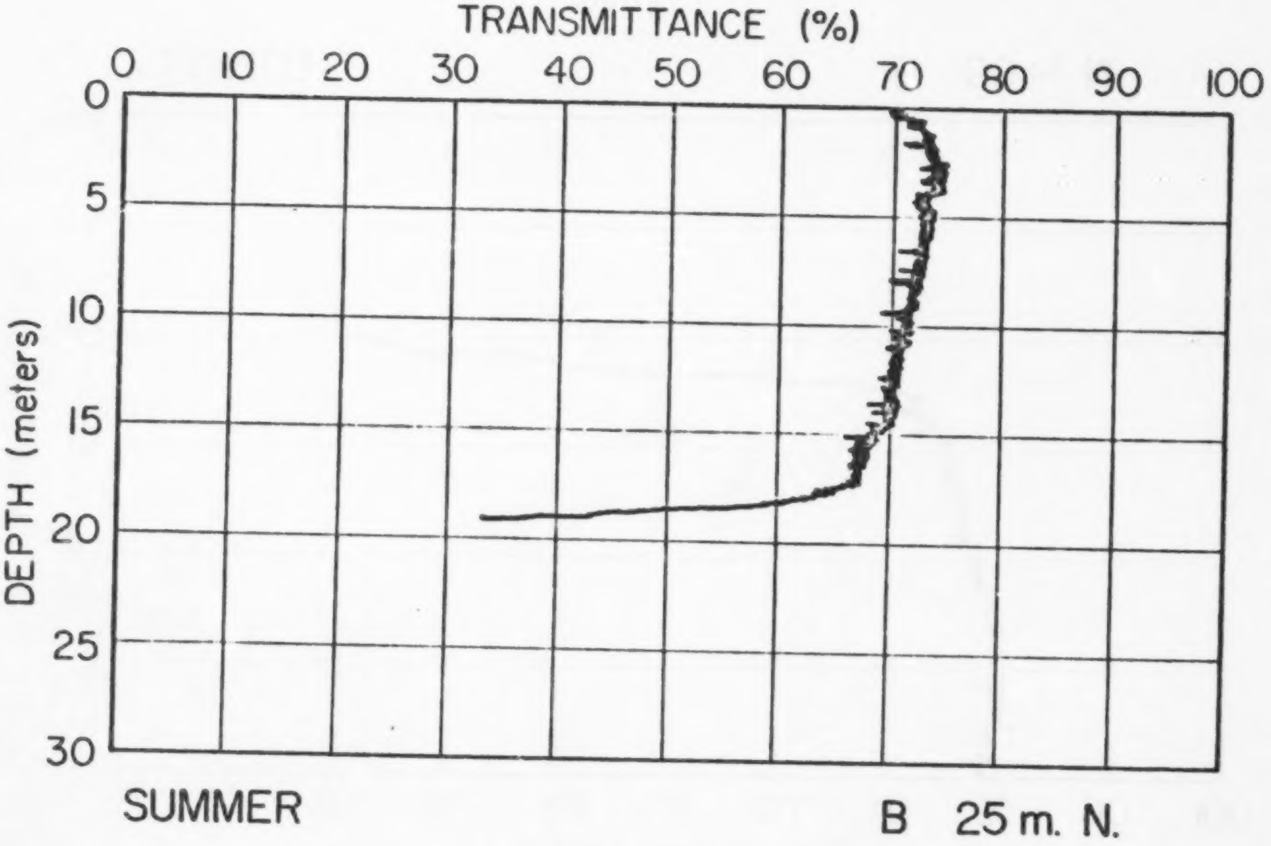
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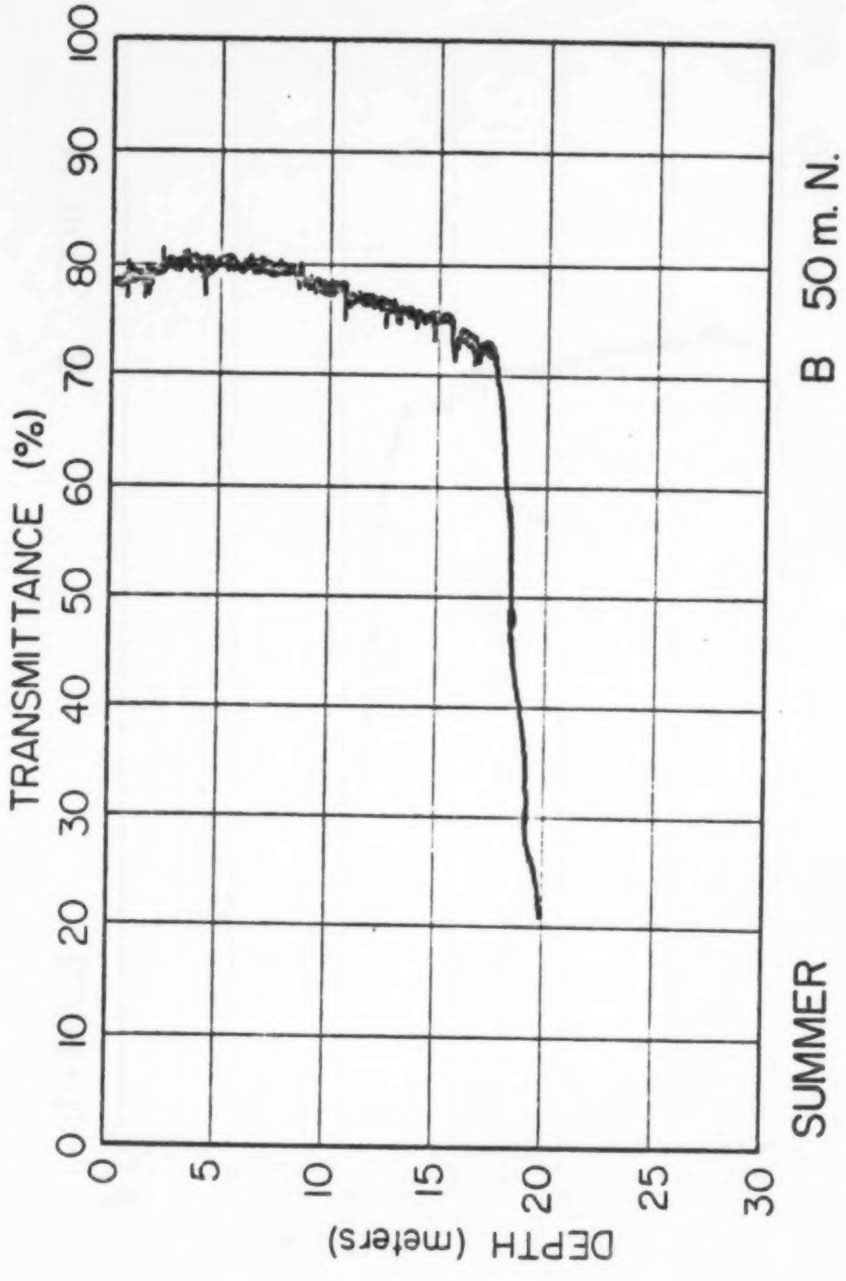
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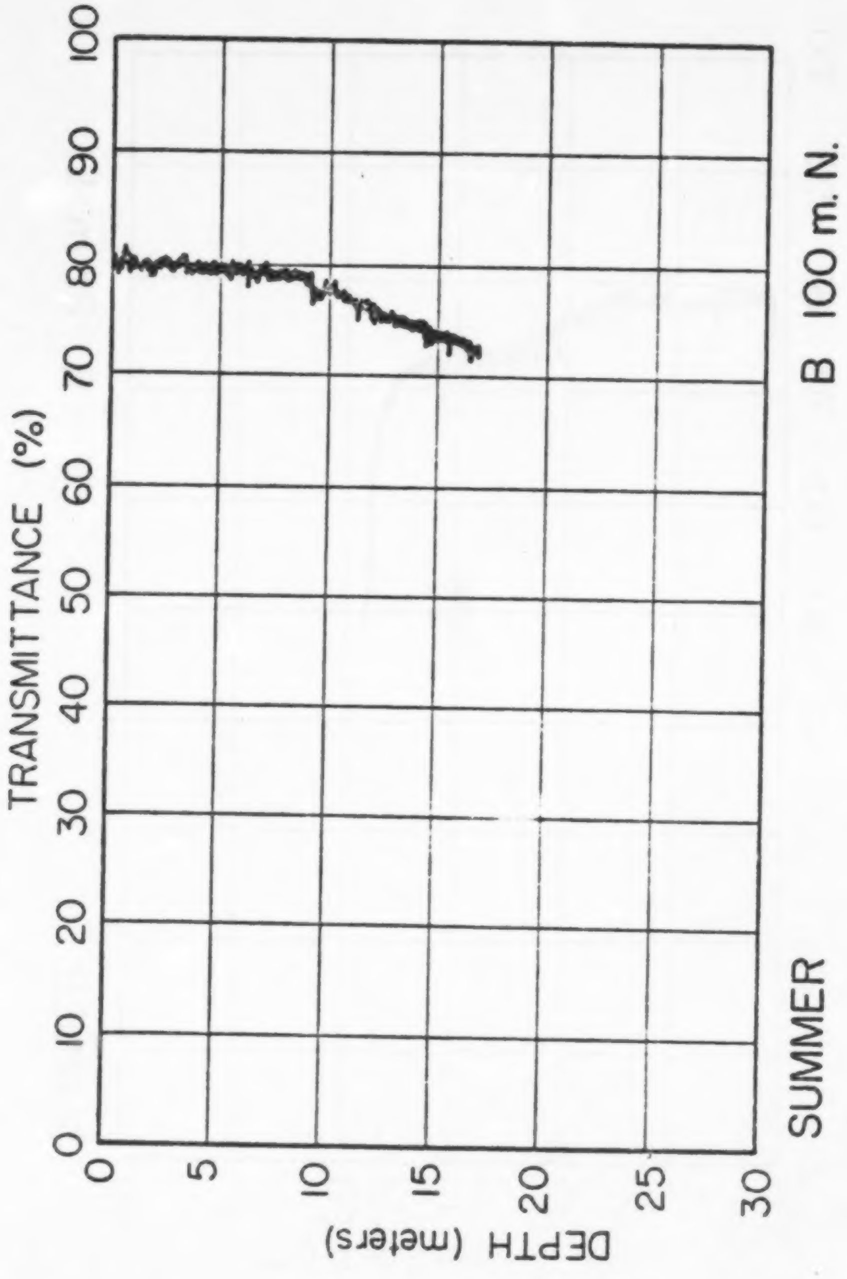
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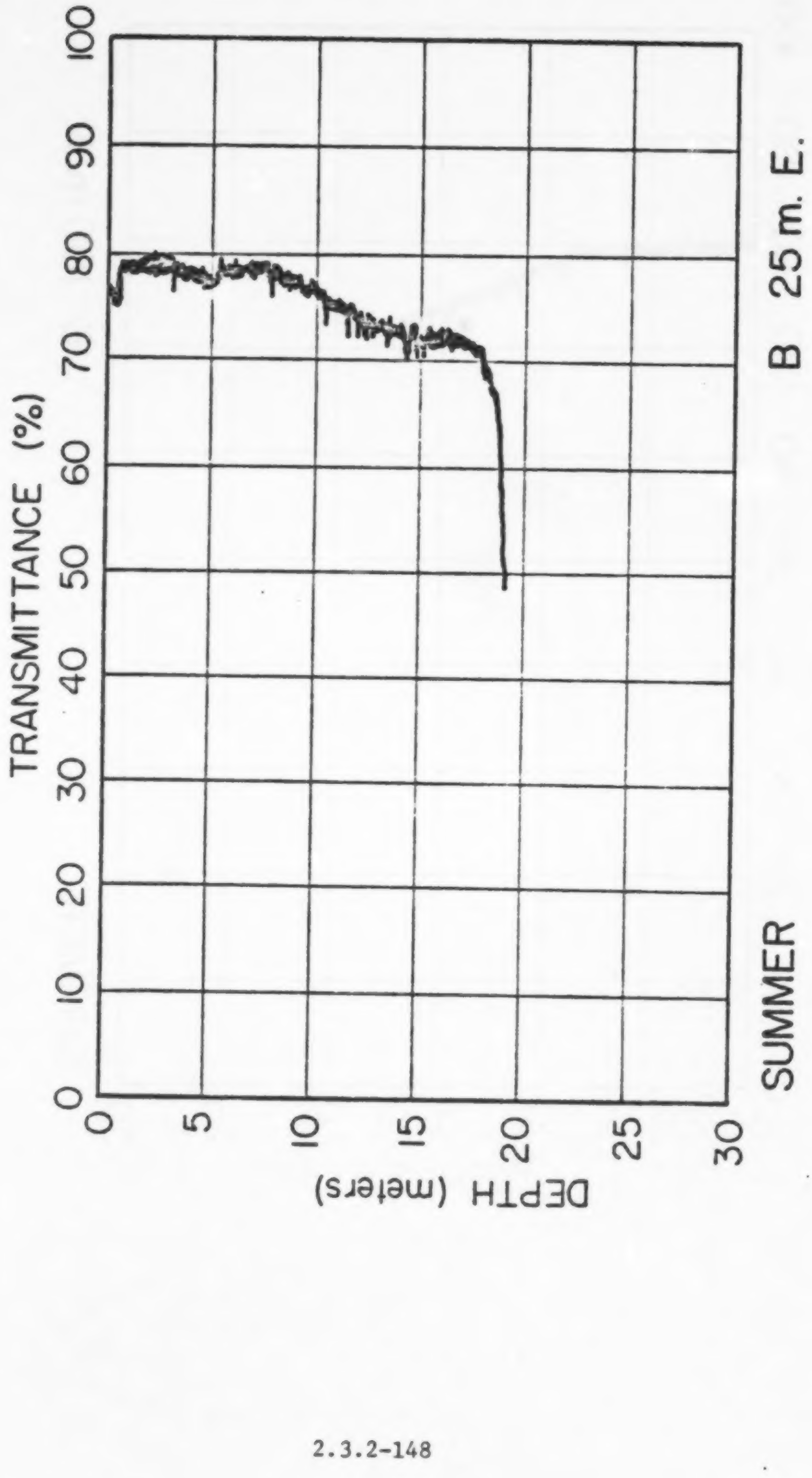
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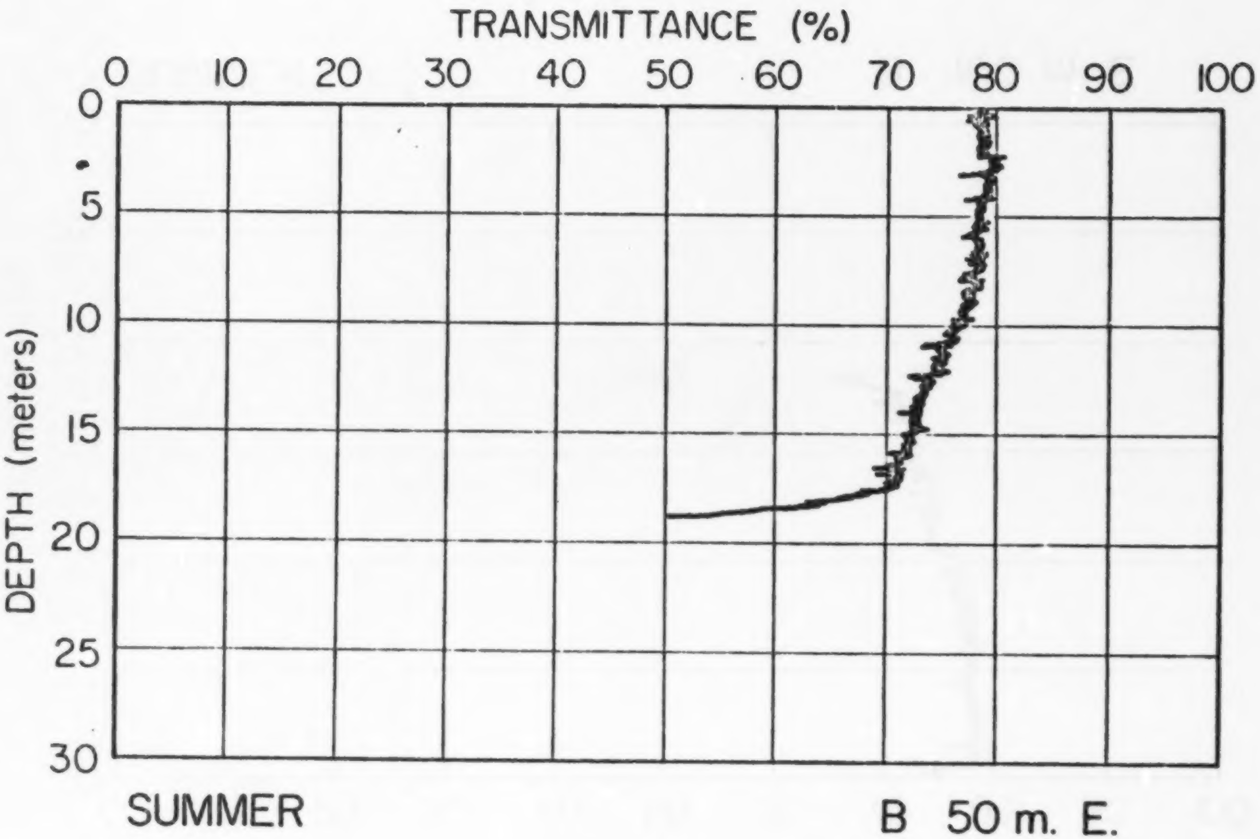
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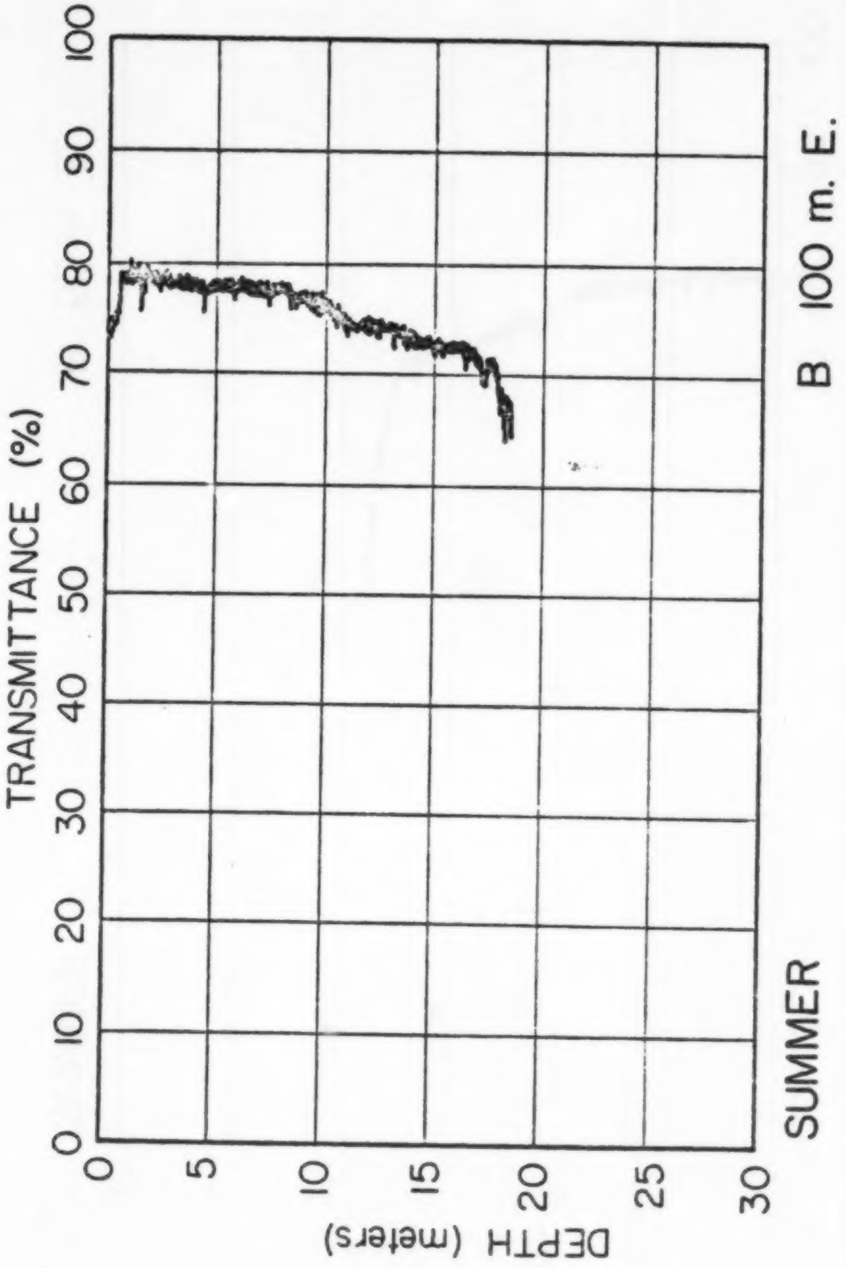
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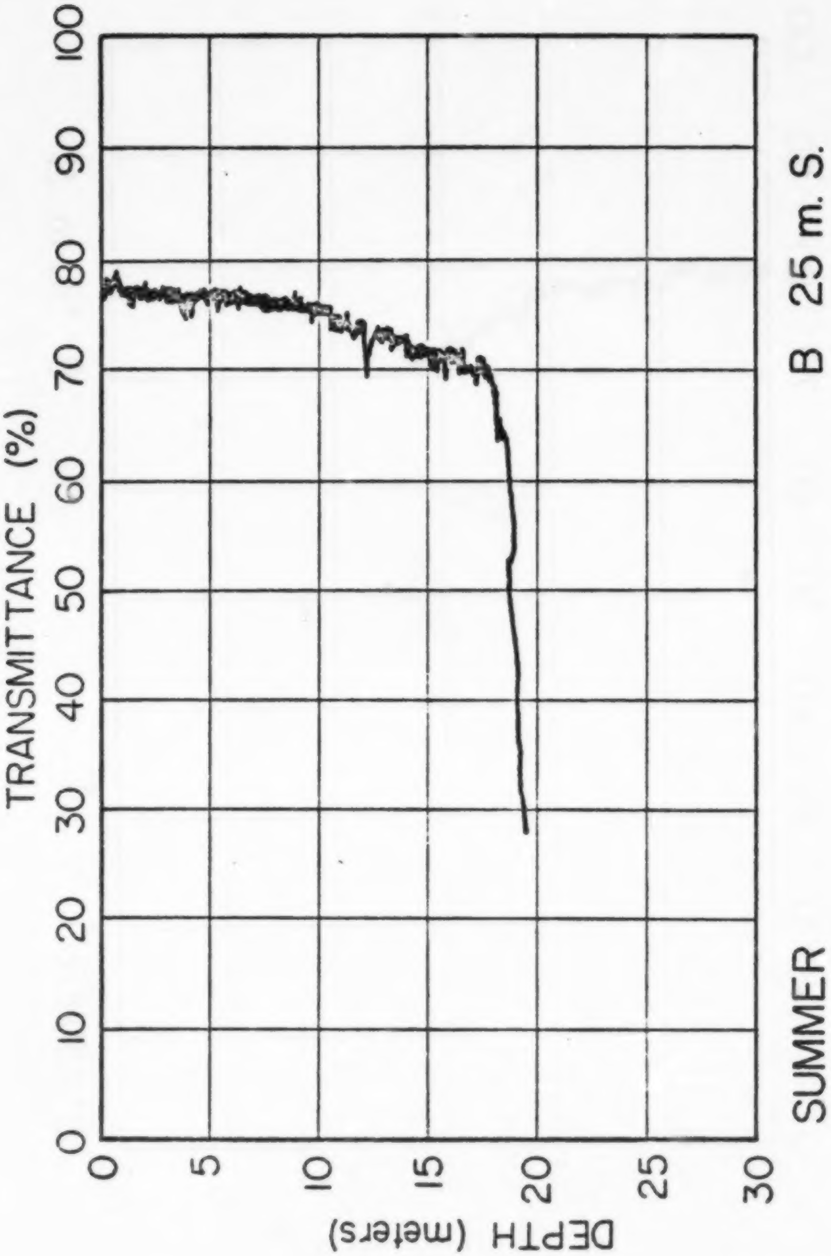
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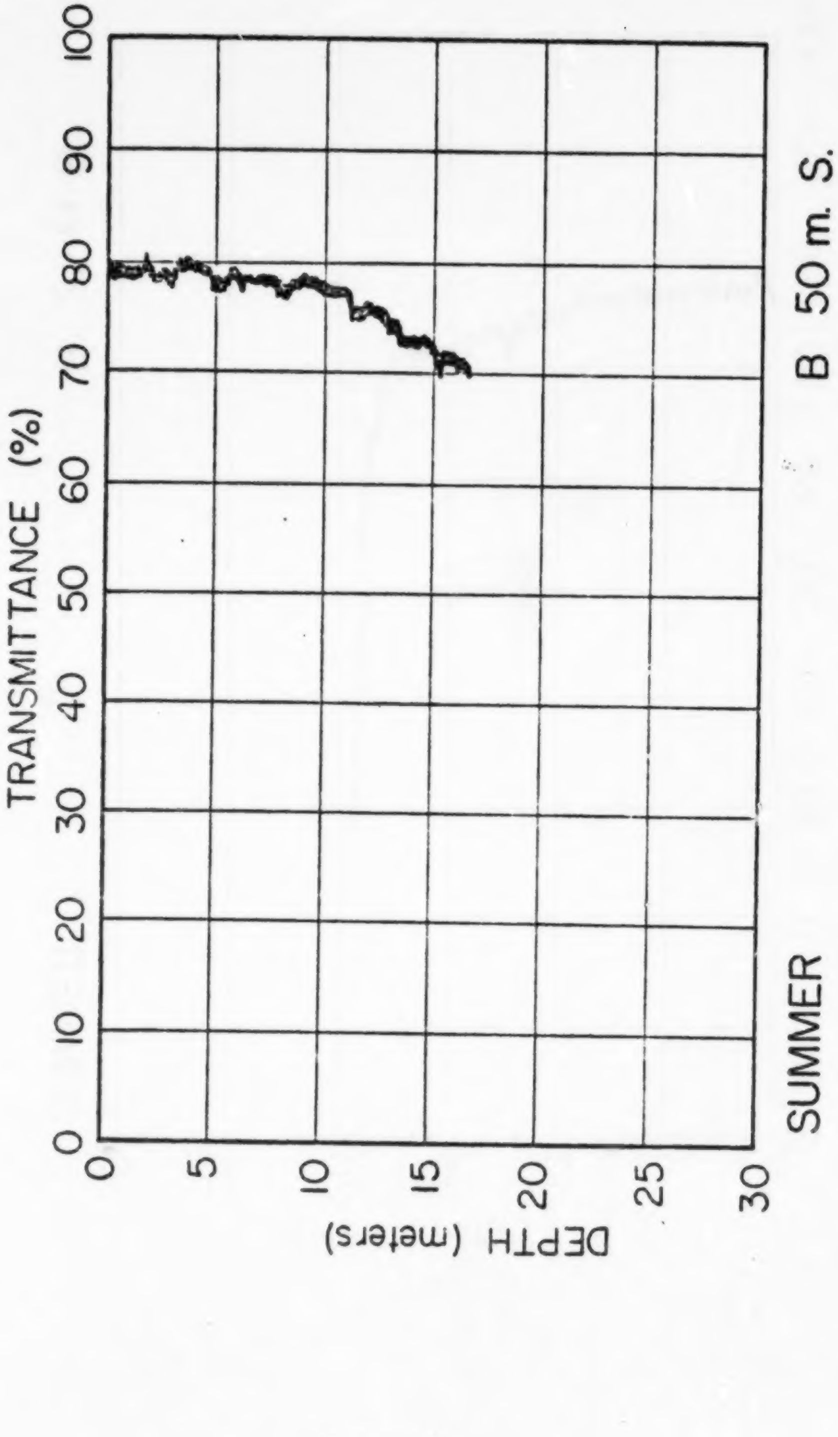
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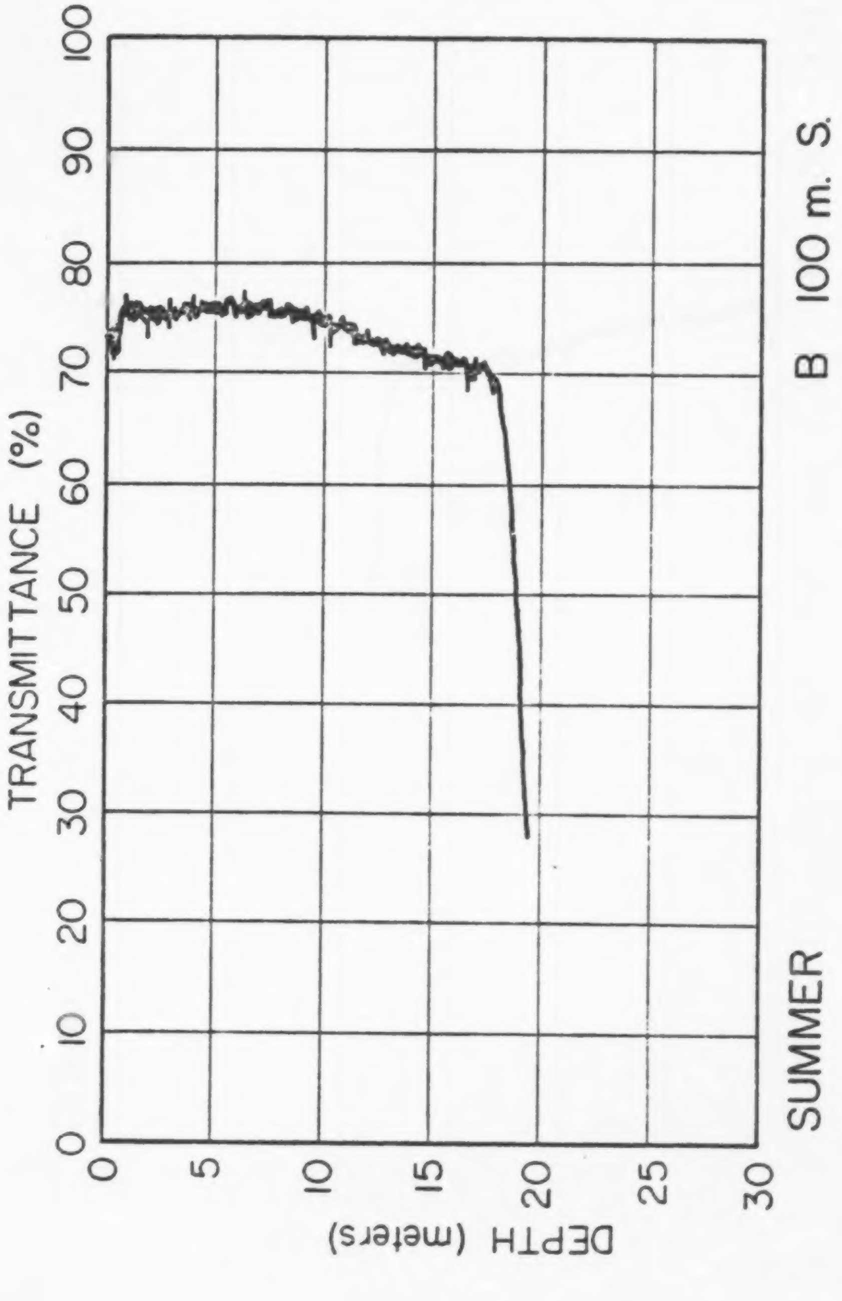
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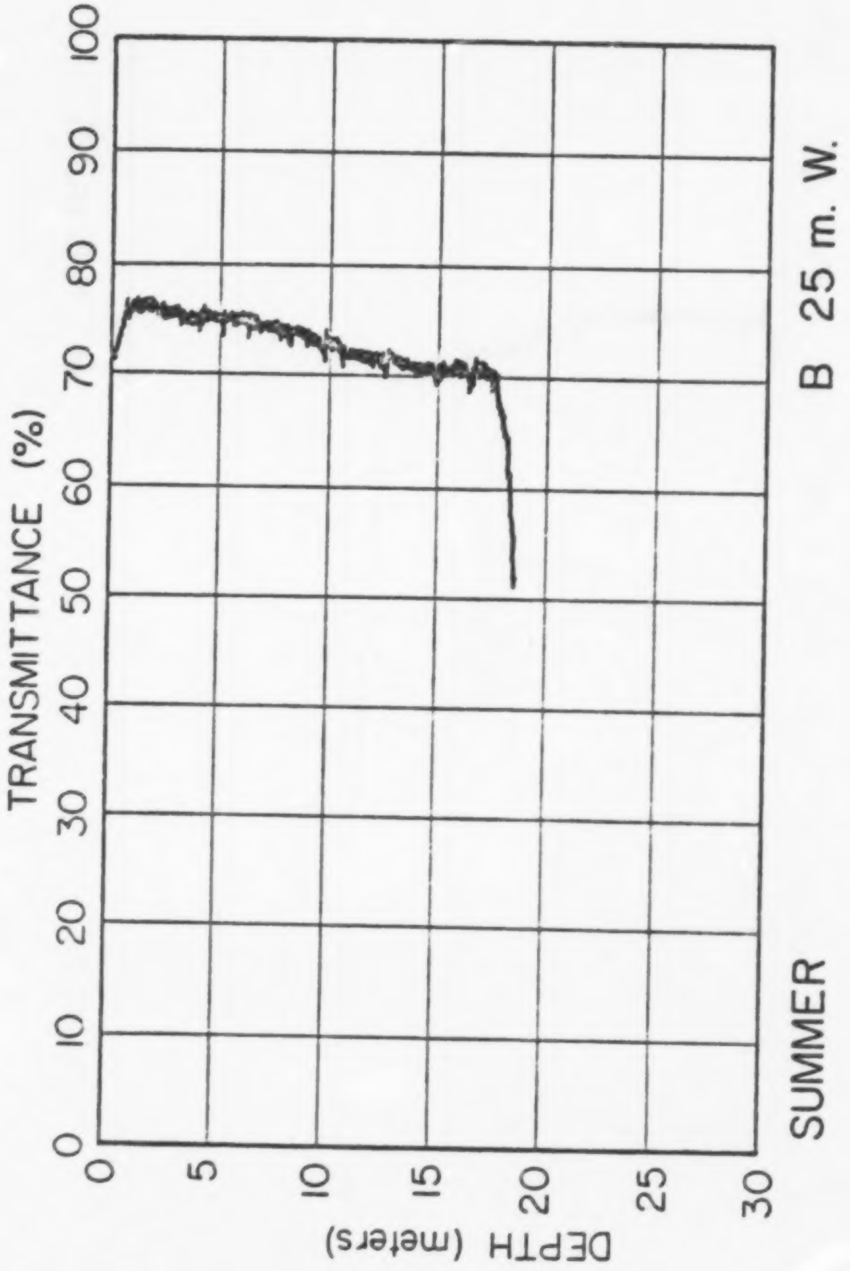
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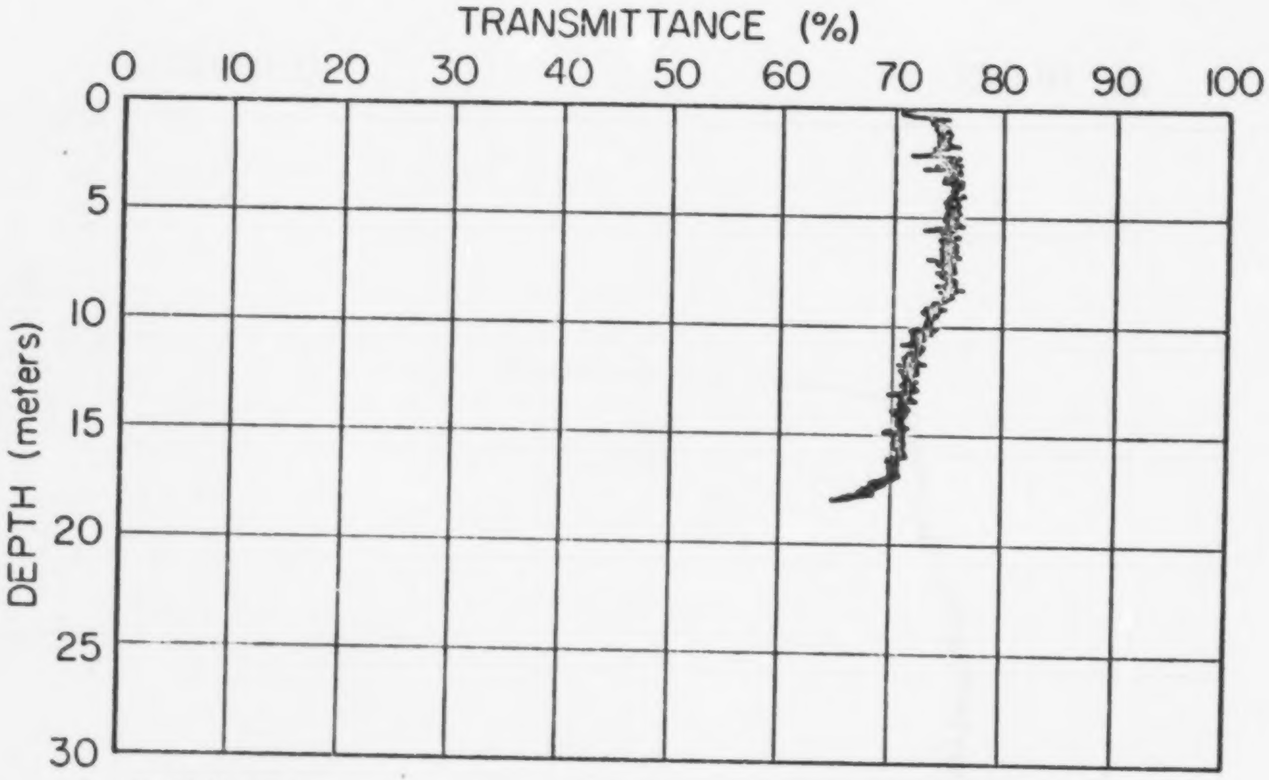

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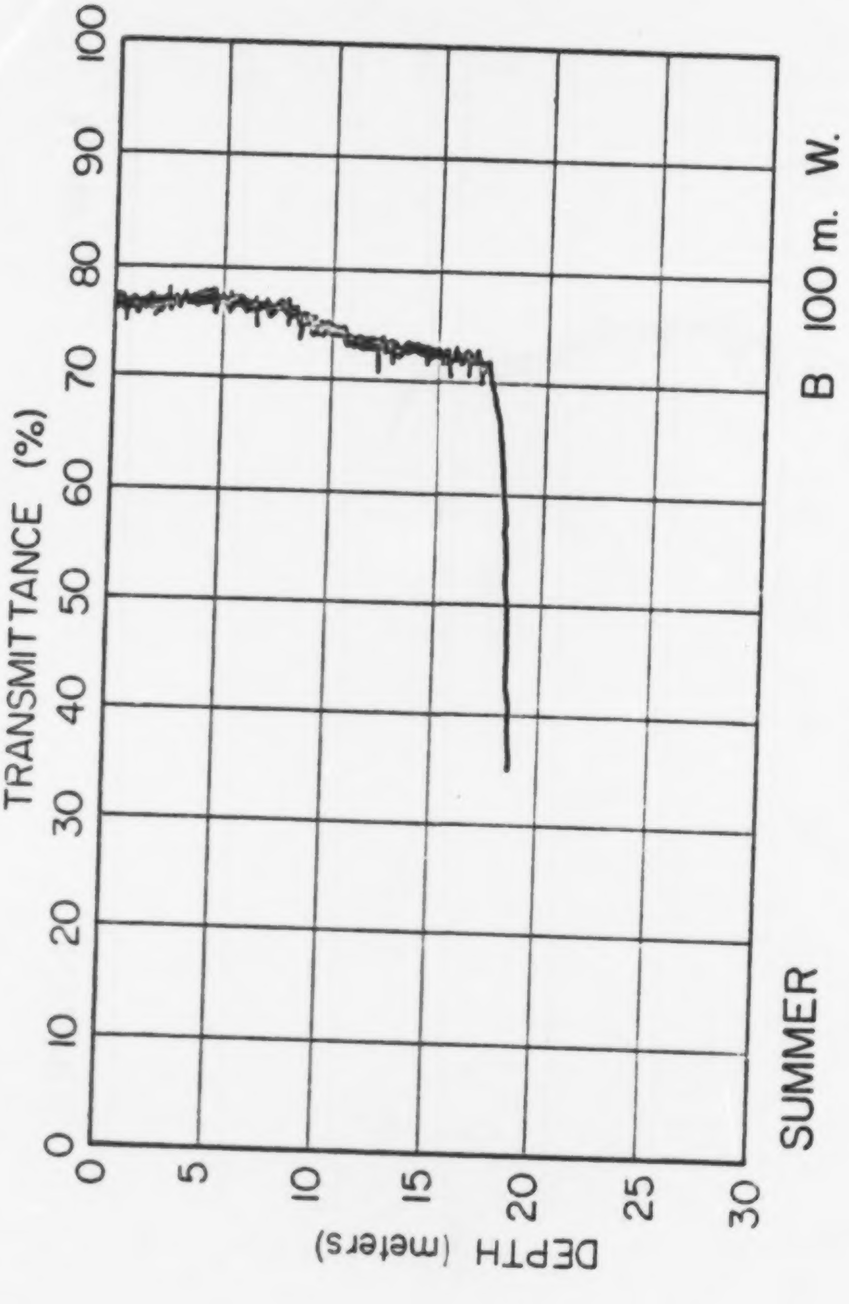
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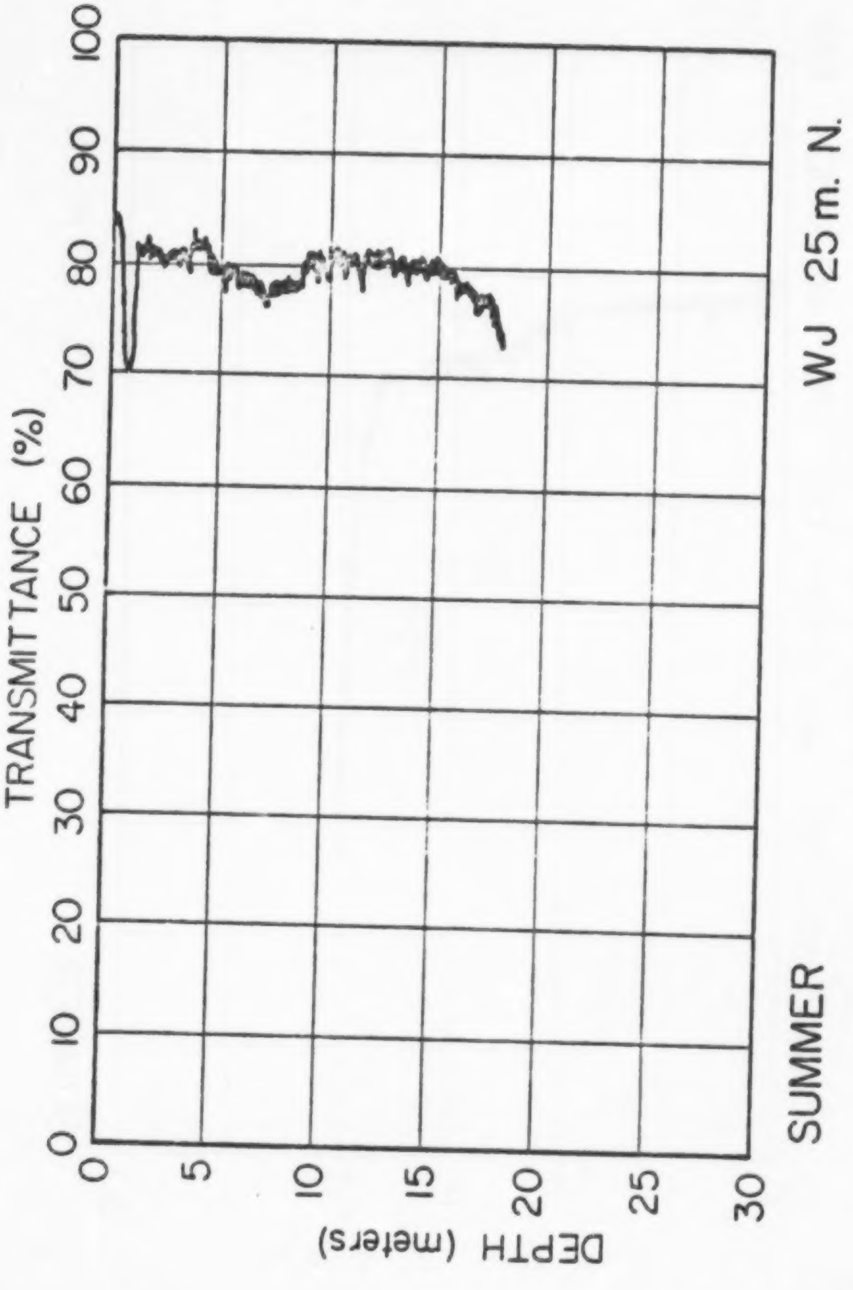
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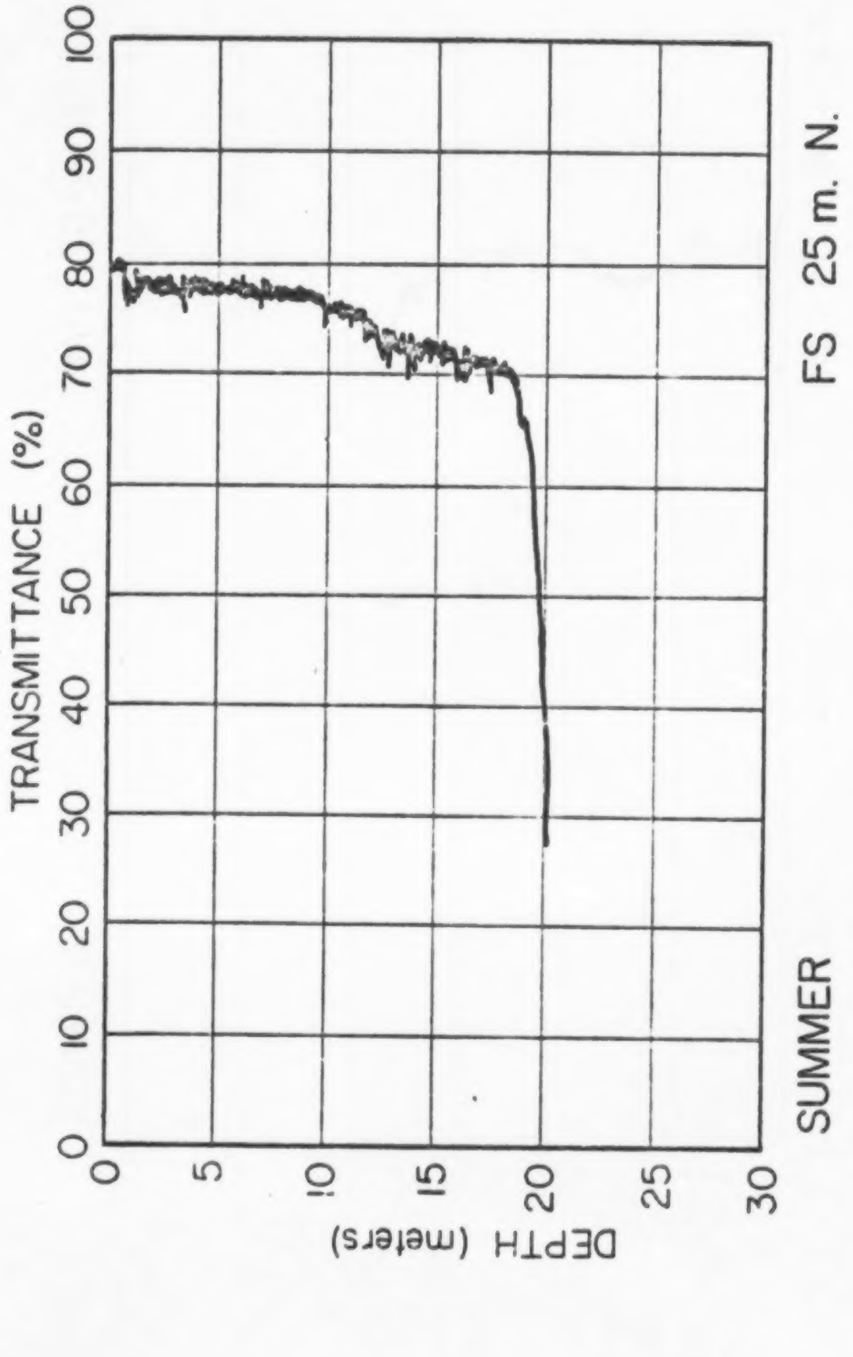
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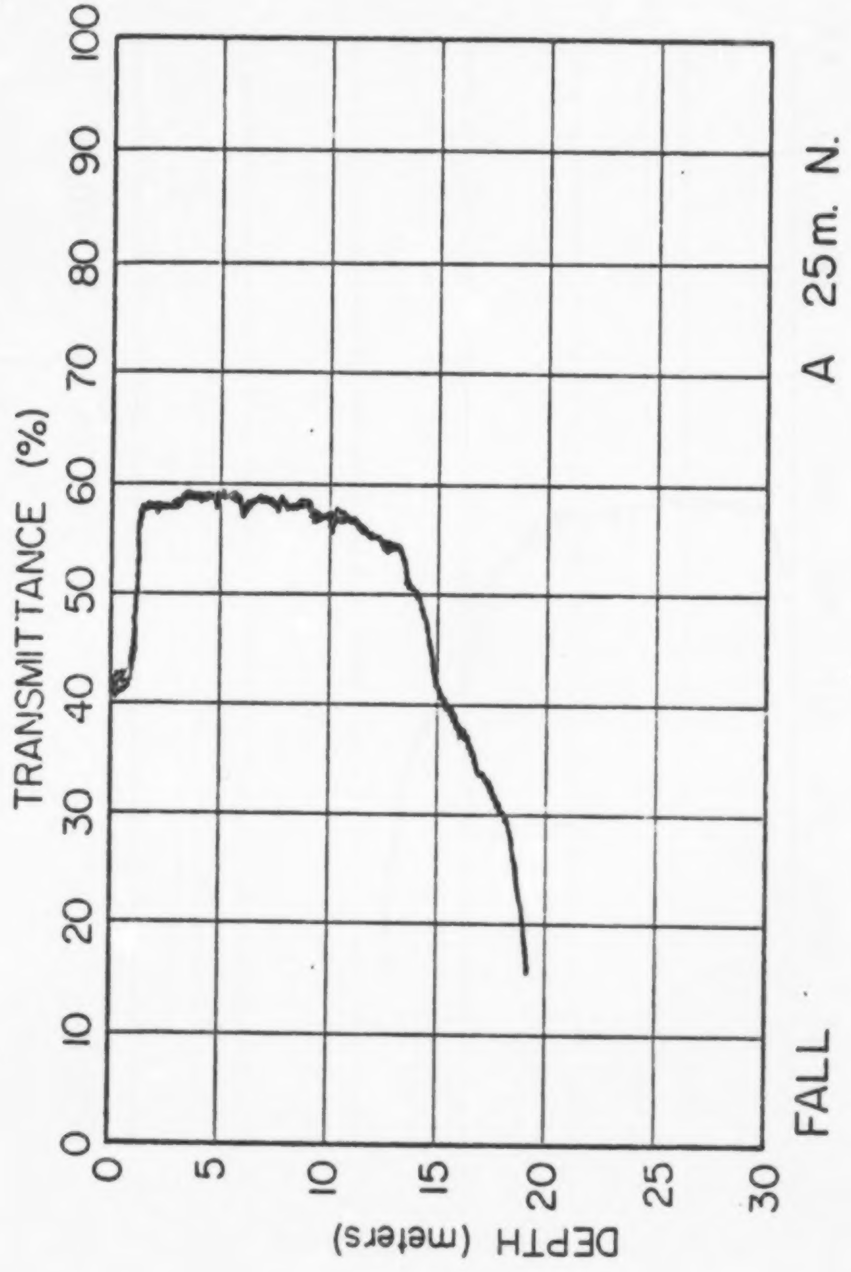
SUMMER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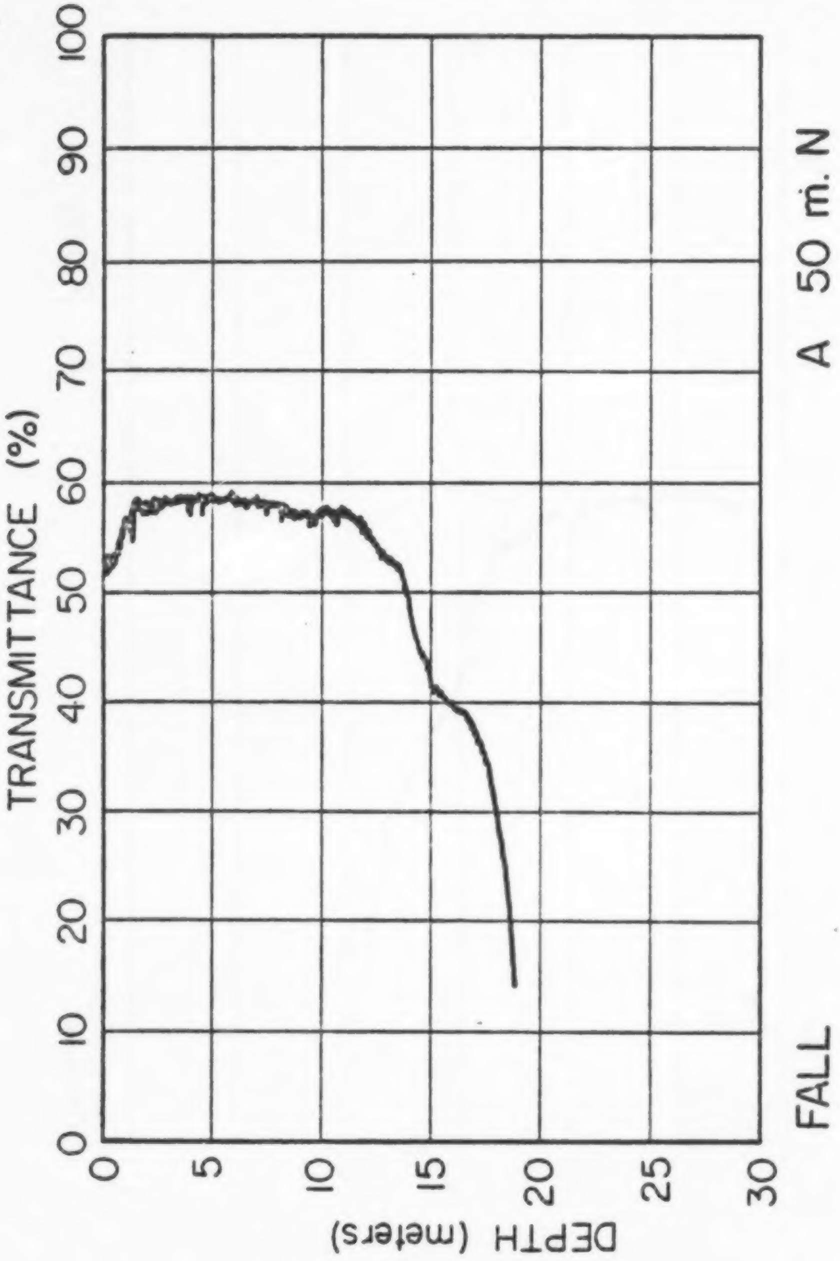
FALL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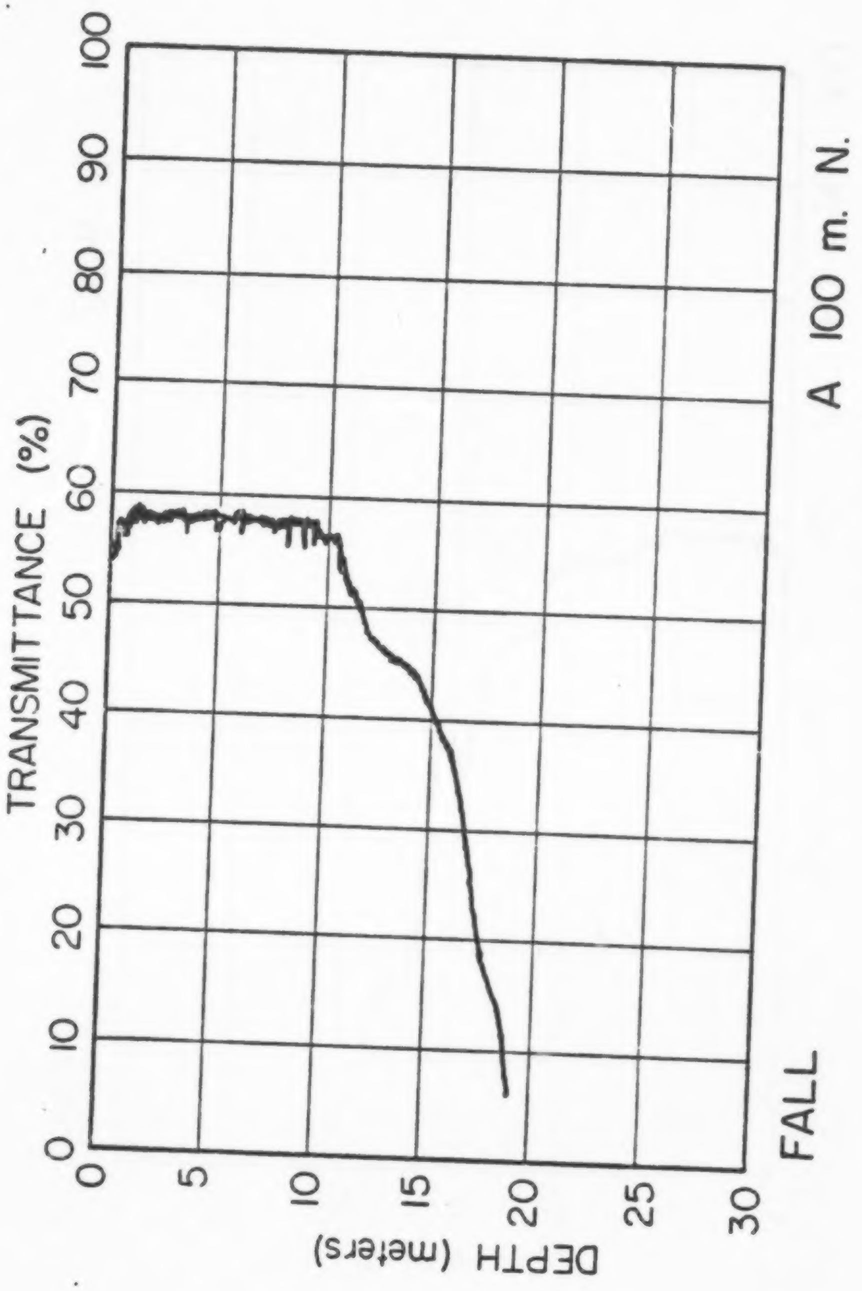
A 50 mi. N
FALL


TRANSMITTANCE (%)
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DEPTH (meters)
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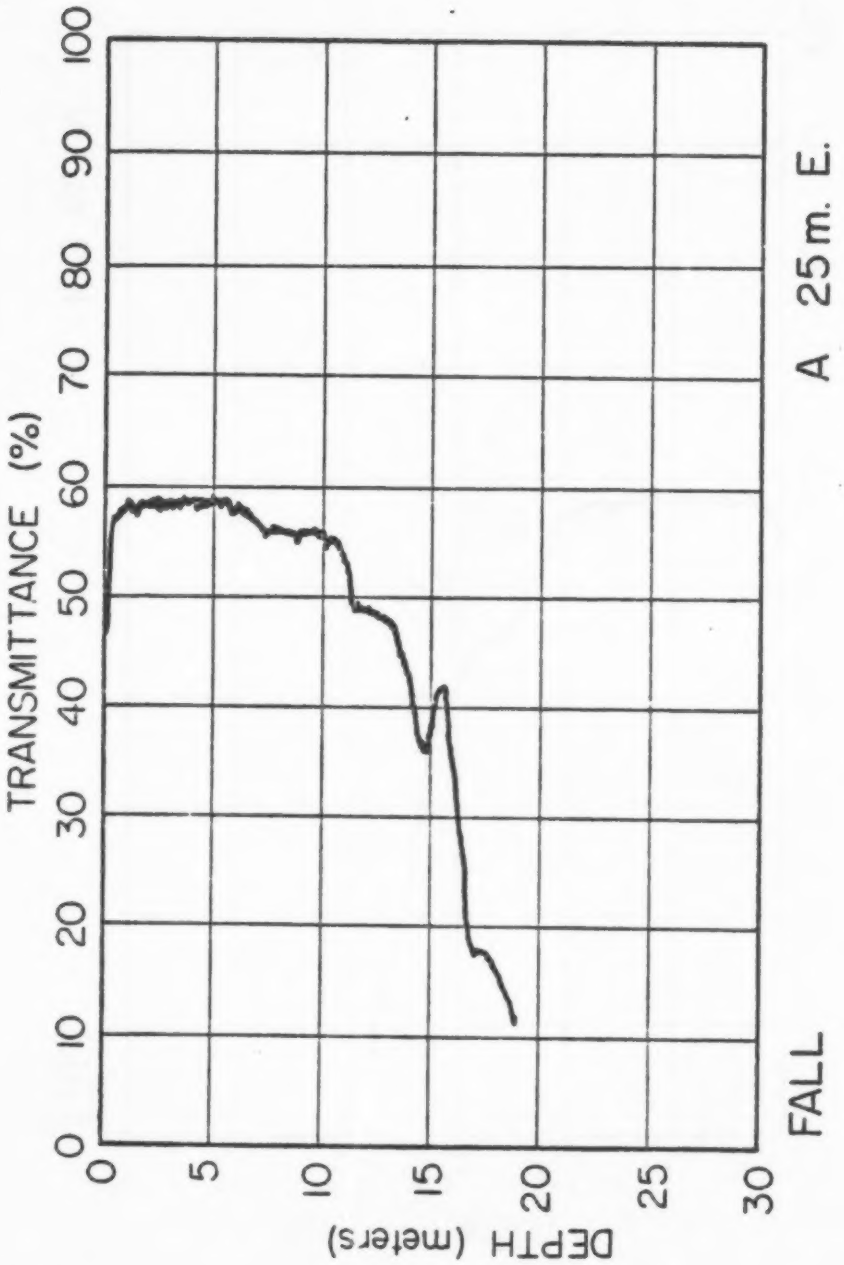
A 100 m. N.
FALL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DEPTH (meters)
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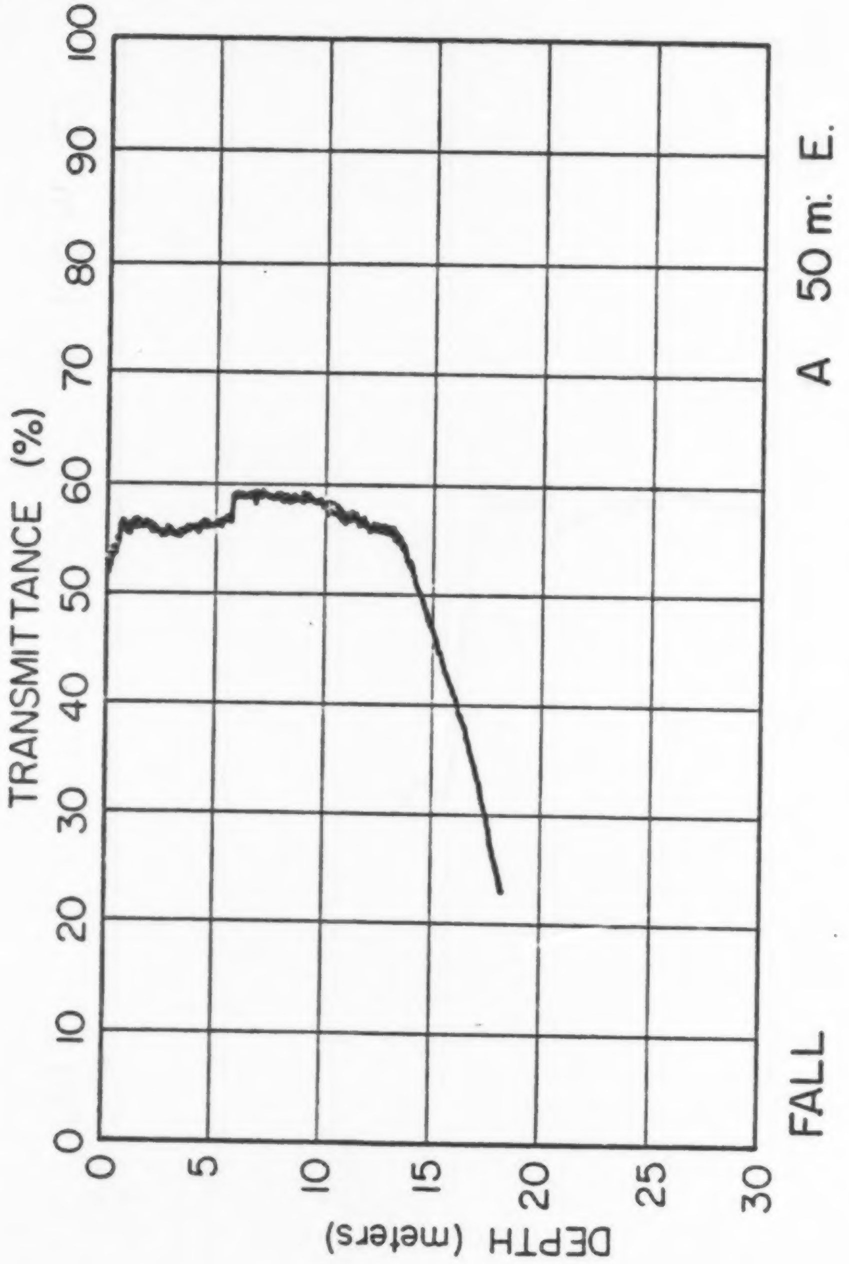
A 25 m. E.
FALL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DEPTH (meters)
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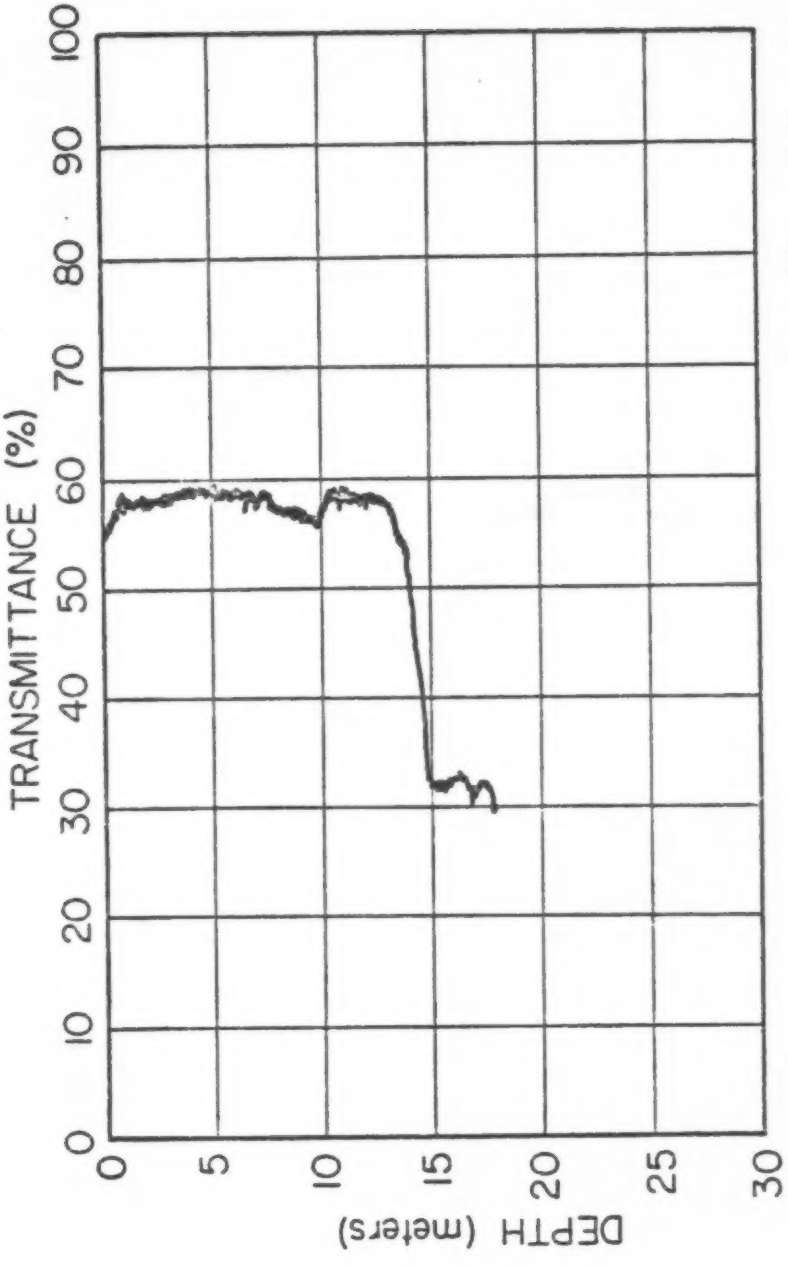
A 50 m: E.
FALL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DEPTH (meters)
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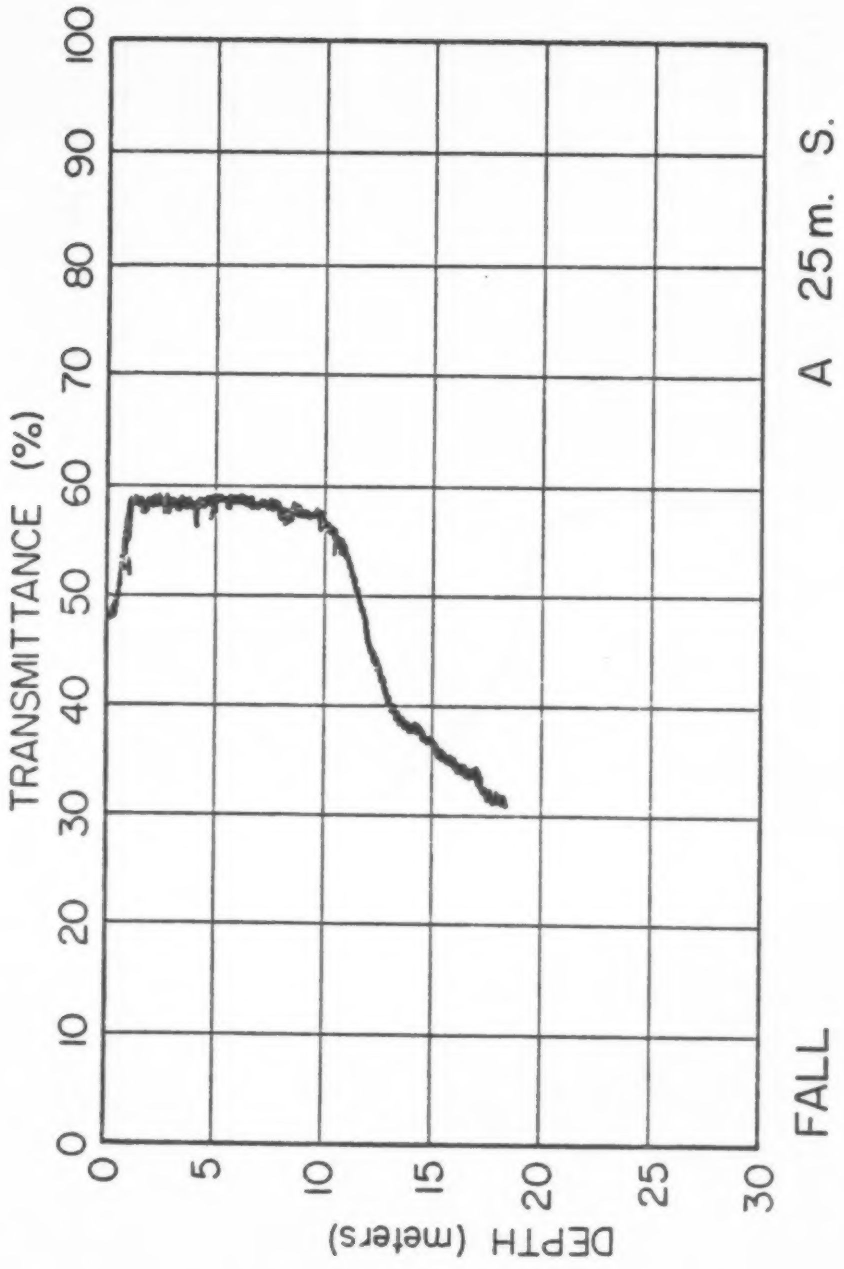
A 100 m. E.

FALL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DEPTH (meters)
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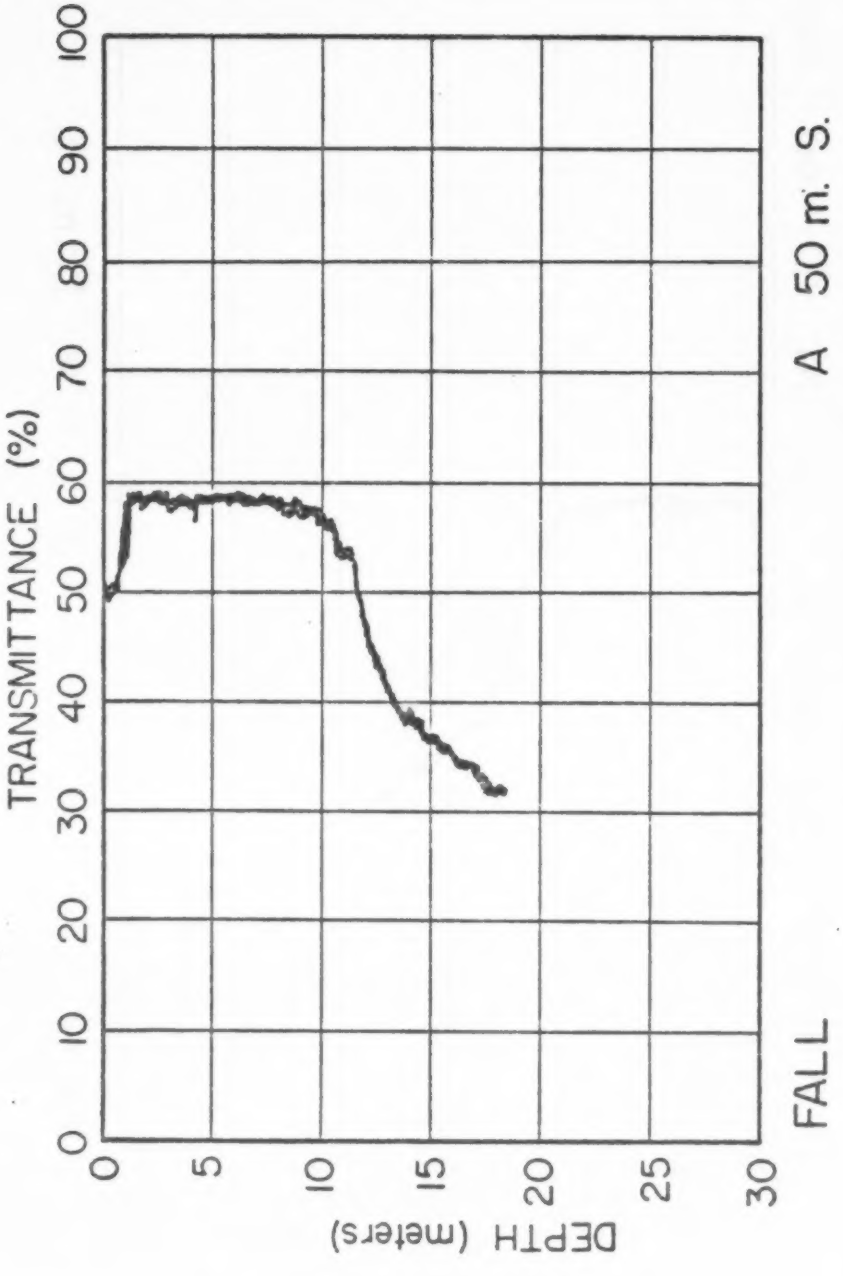
FALL
A 25 m. S.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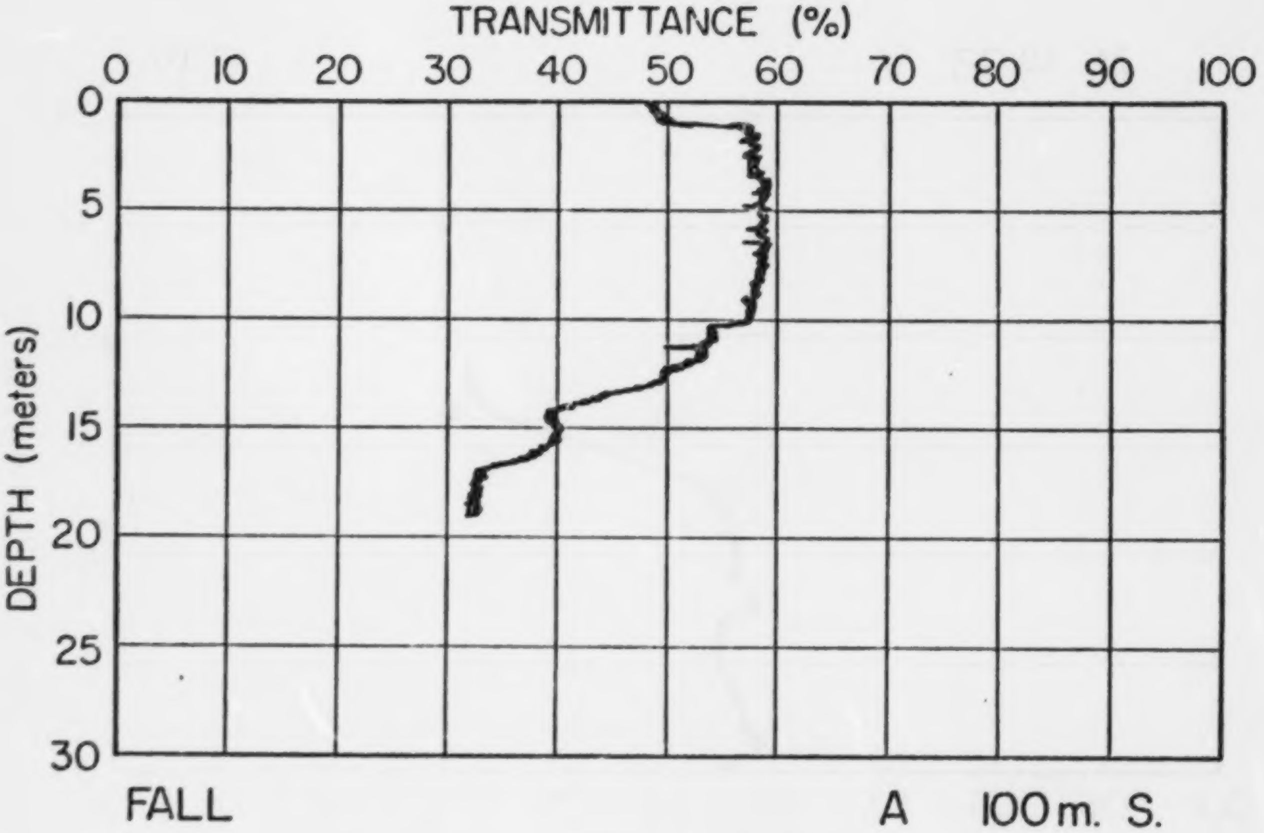
FALL
A 50 m. S.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DEPTH (meters)
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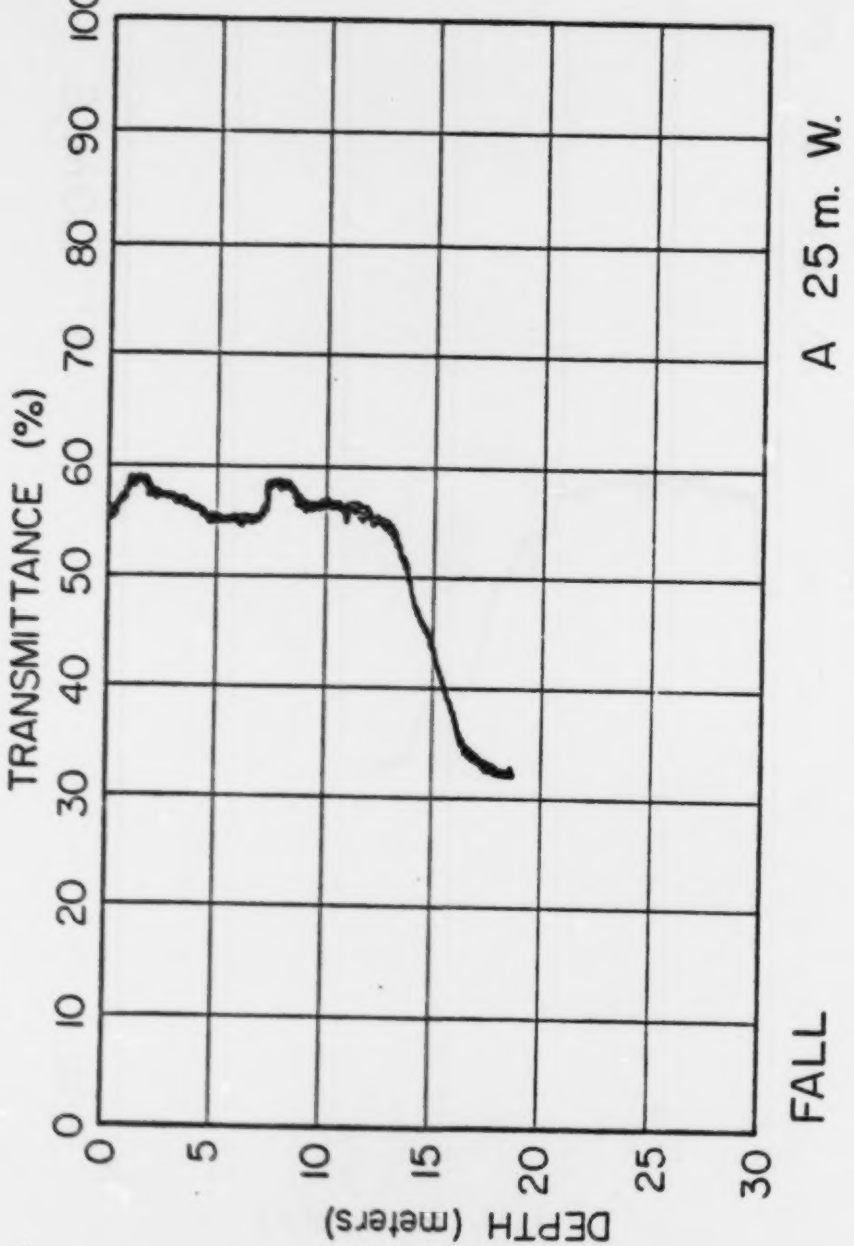
FALL
A 100m. S.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DEPTH (meters)
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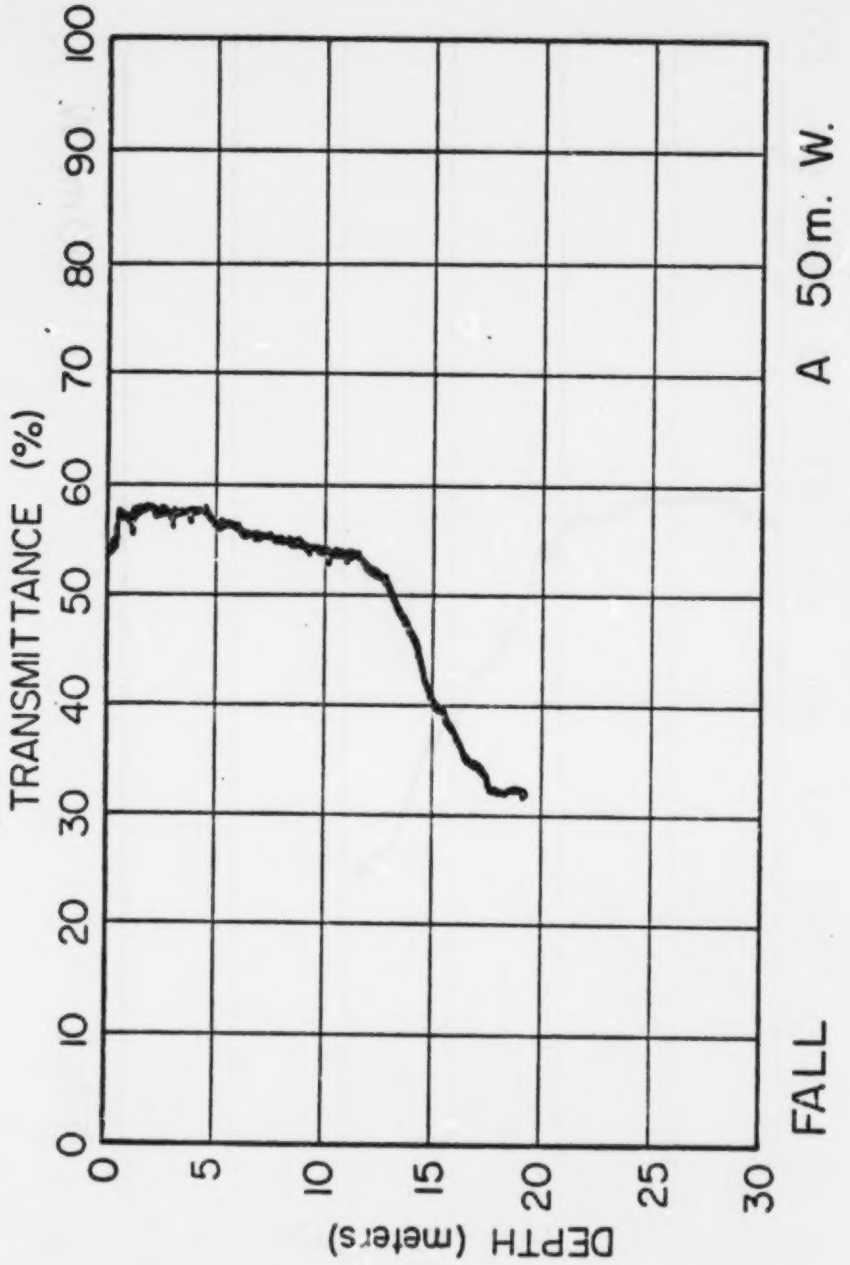
A 25 m. W.
FALL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DEPTH (meters)
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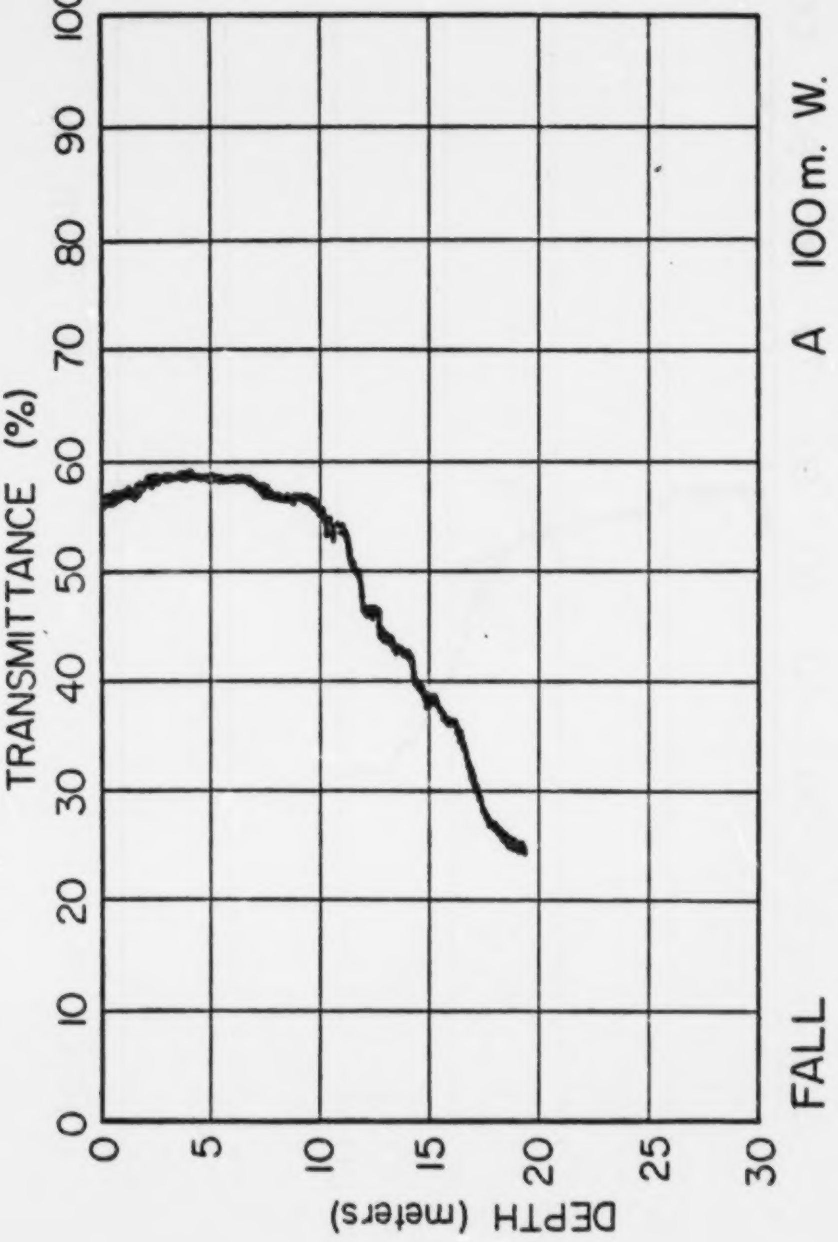
A 50m. W.
FALL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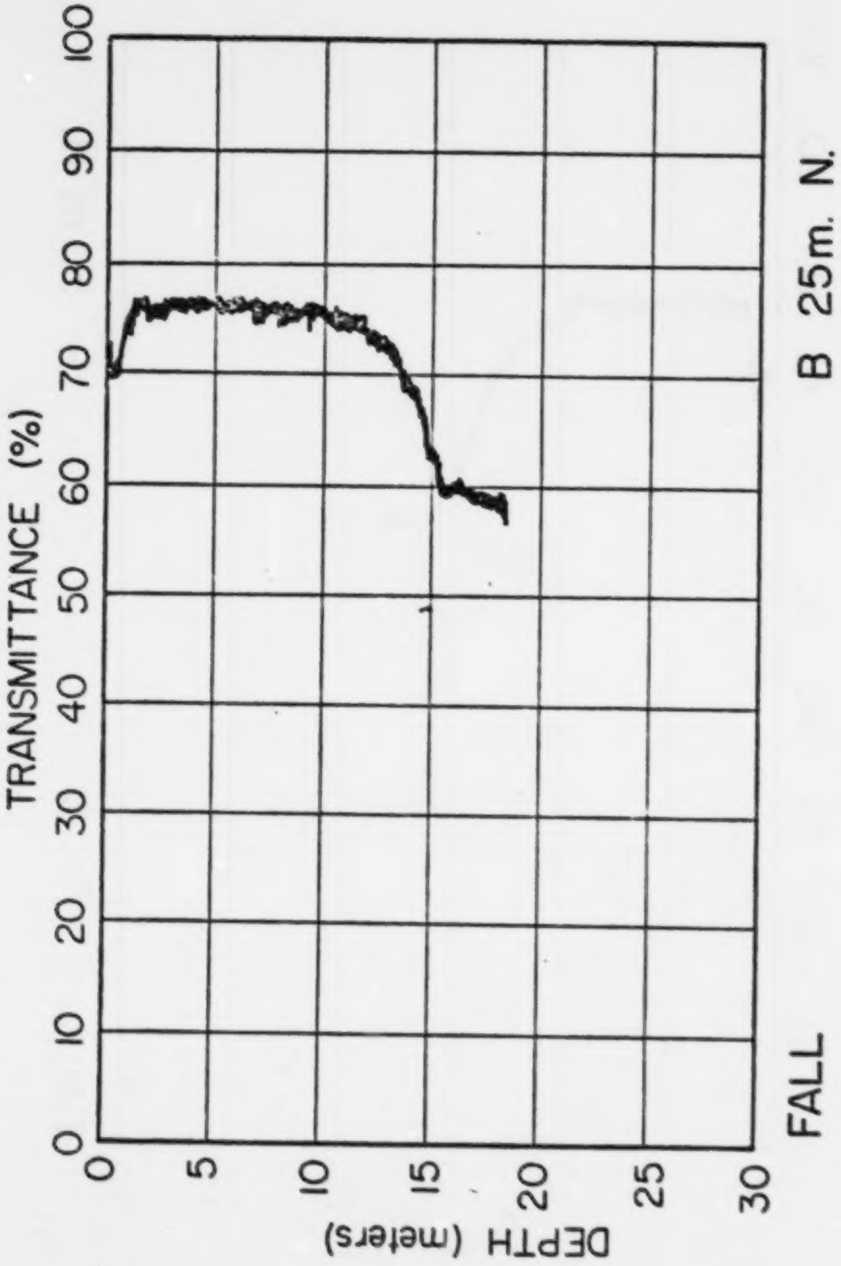
A 100m. W.
FALL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DEPTH (meters)
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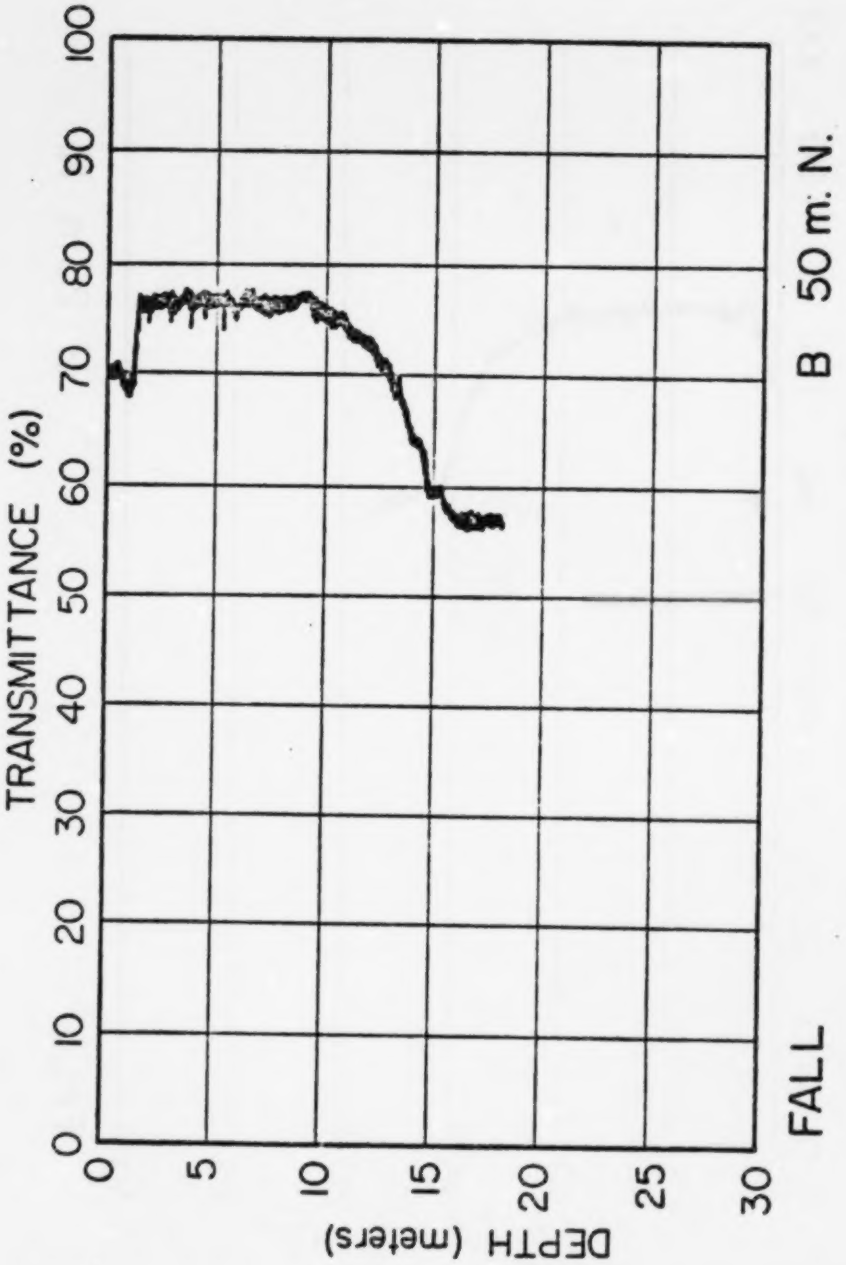
B 25m. N.
FALL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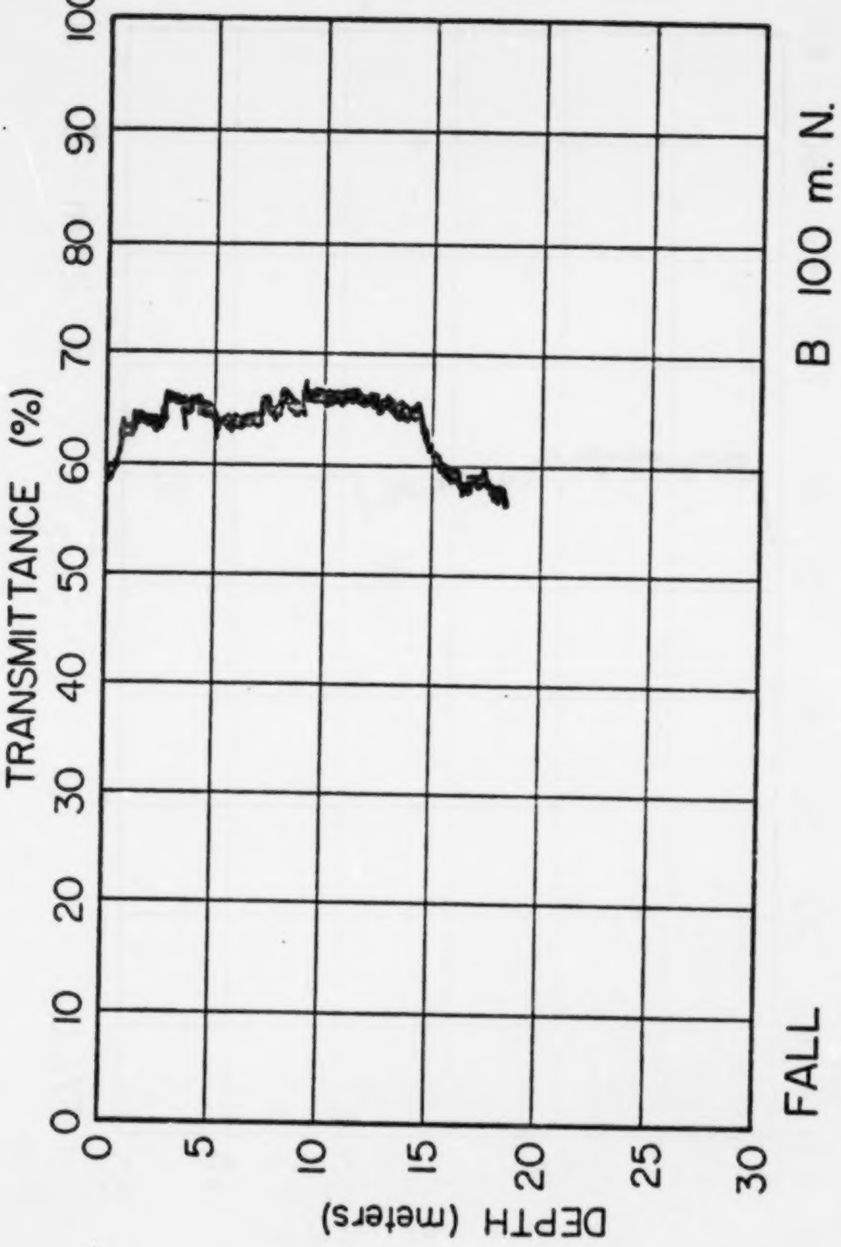
B 50 m. N.
FALL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DEPTH (meters)
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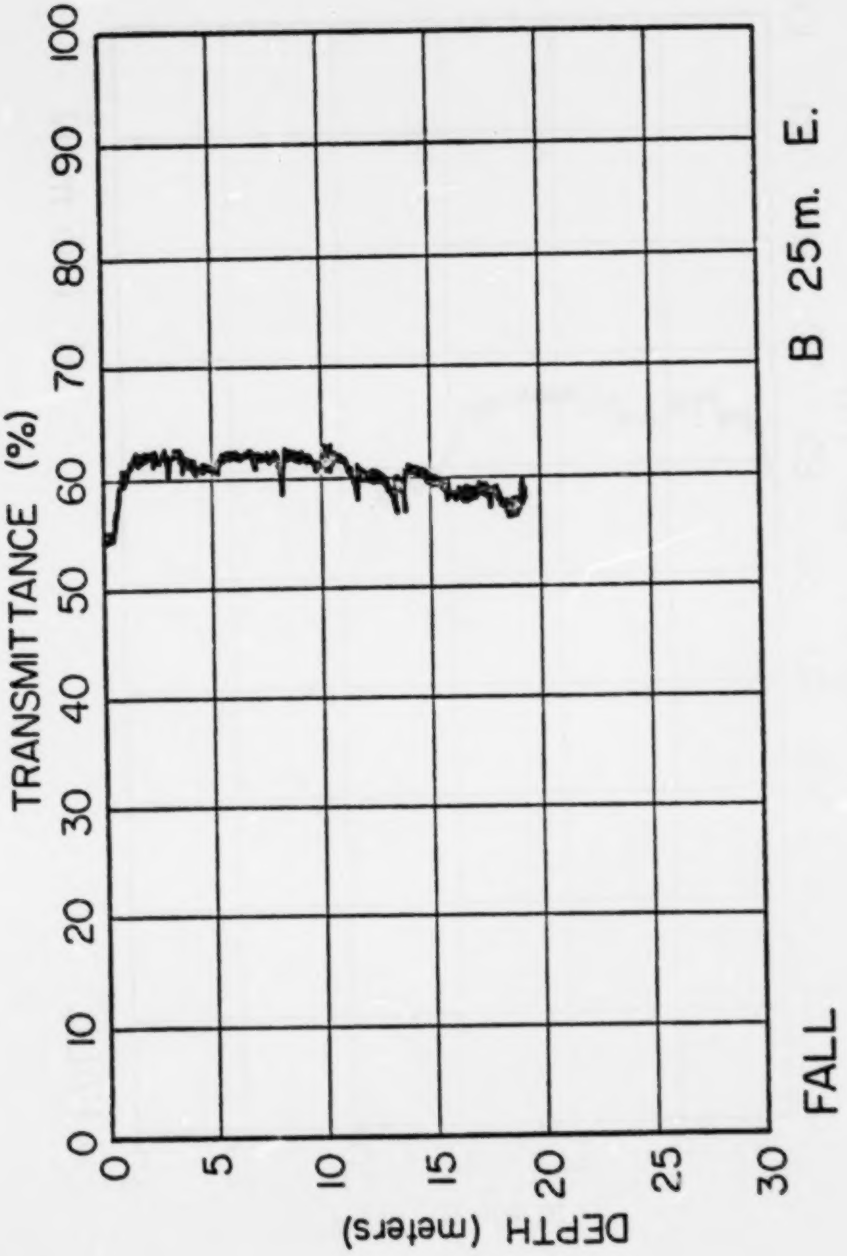
B 100 m. N.
FALL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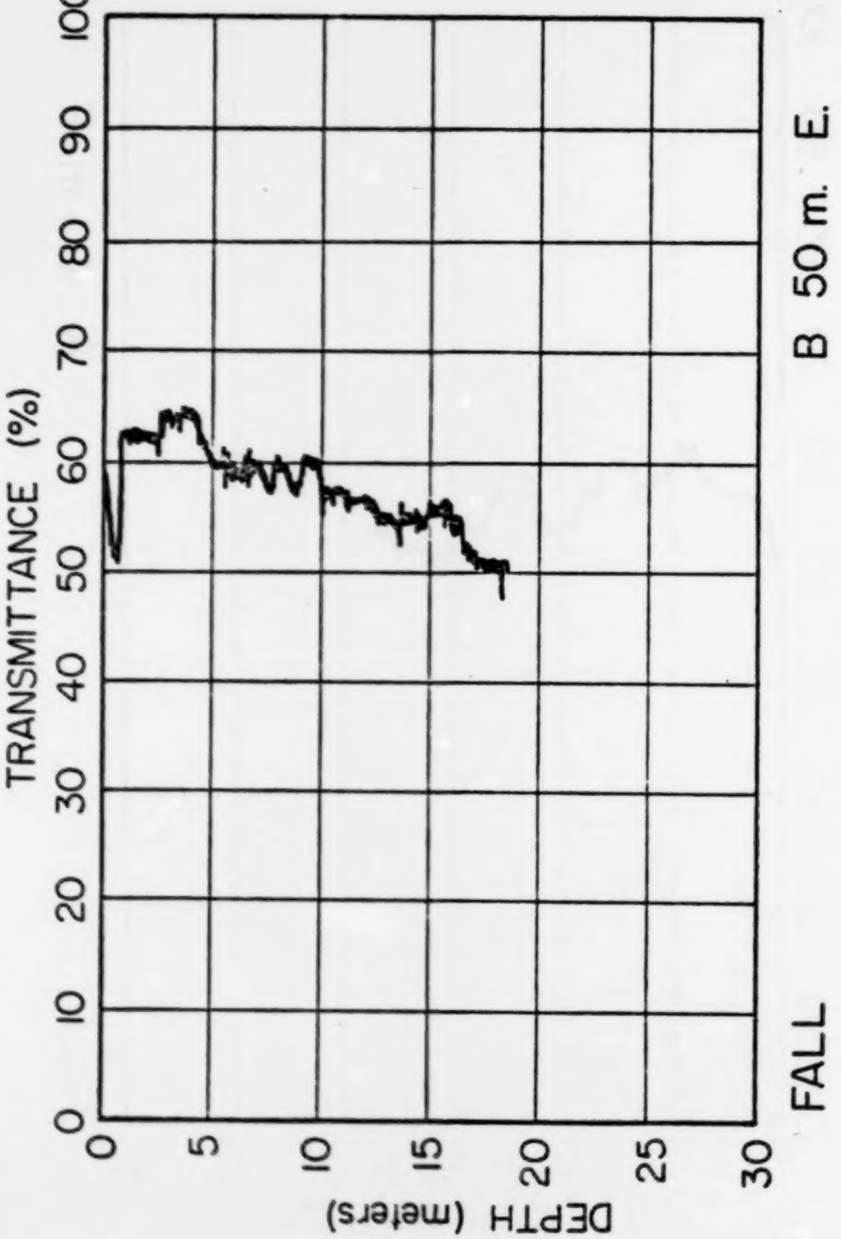
B 25m. E.
FALL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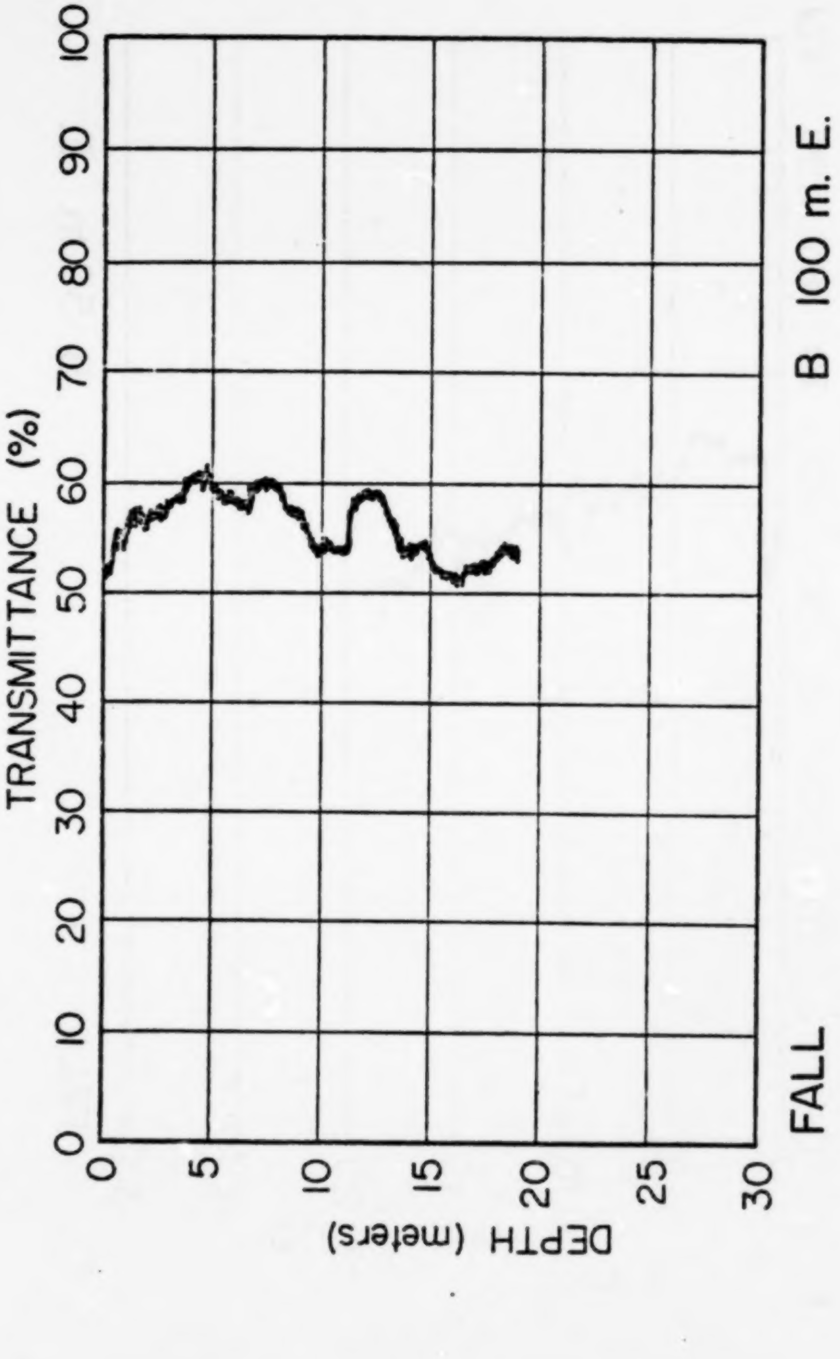
B 50 m. E.
FALL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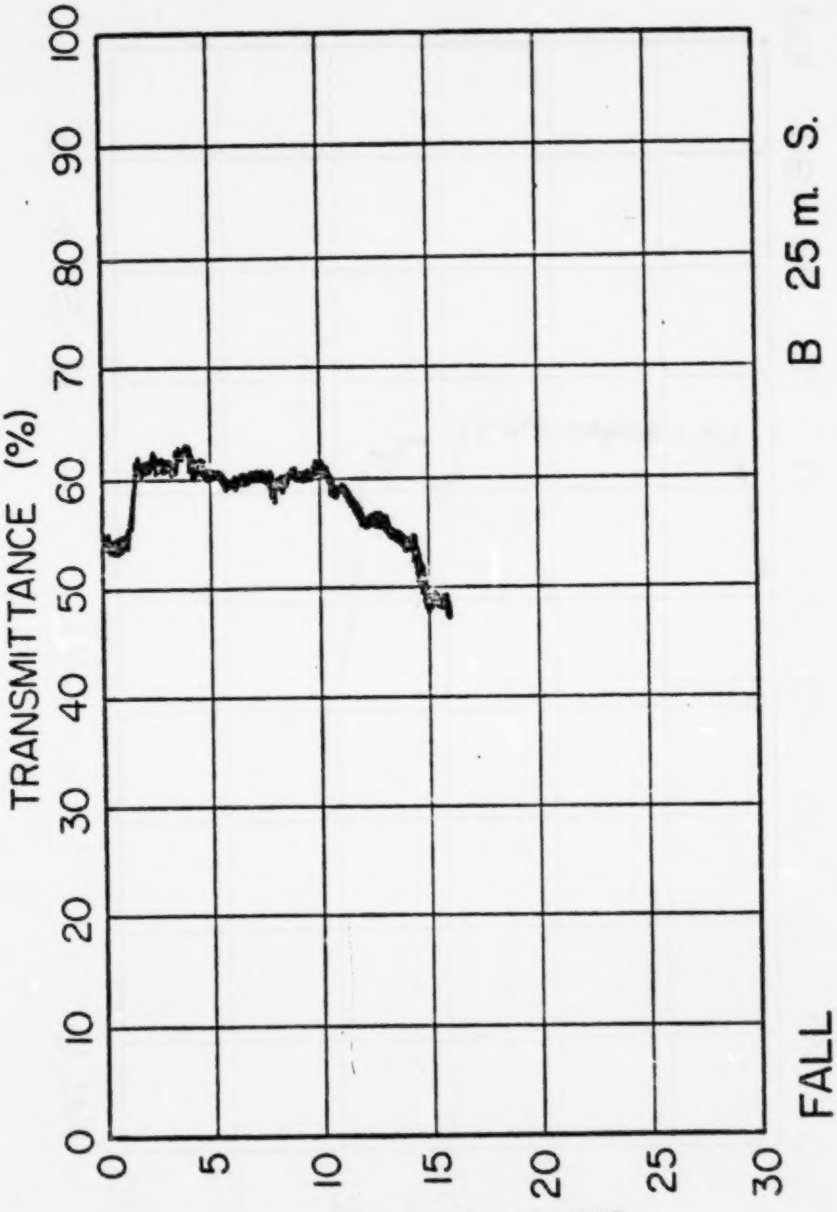
B 100 m. E.
FALL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DEPTH (meters)
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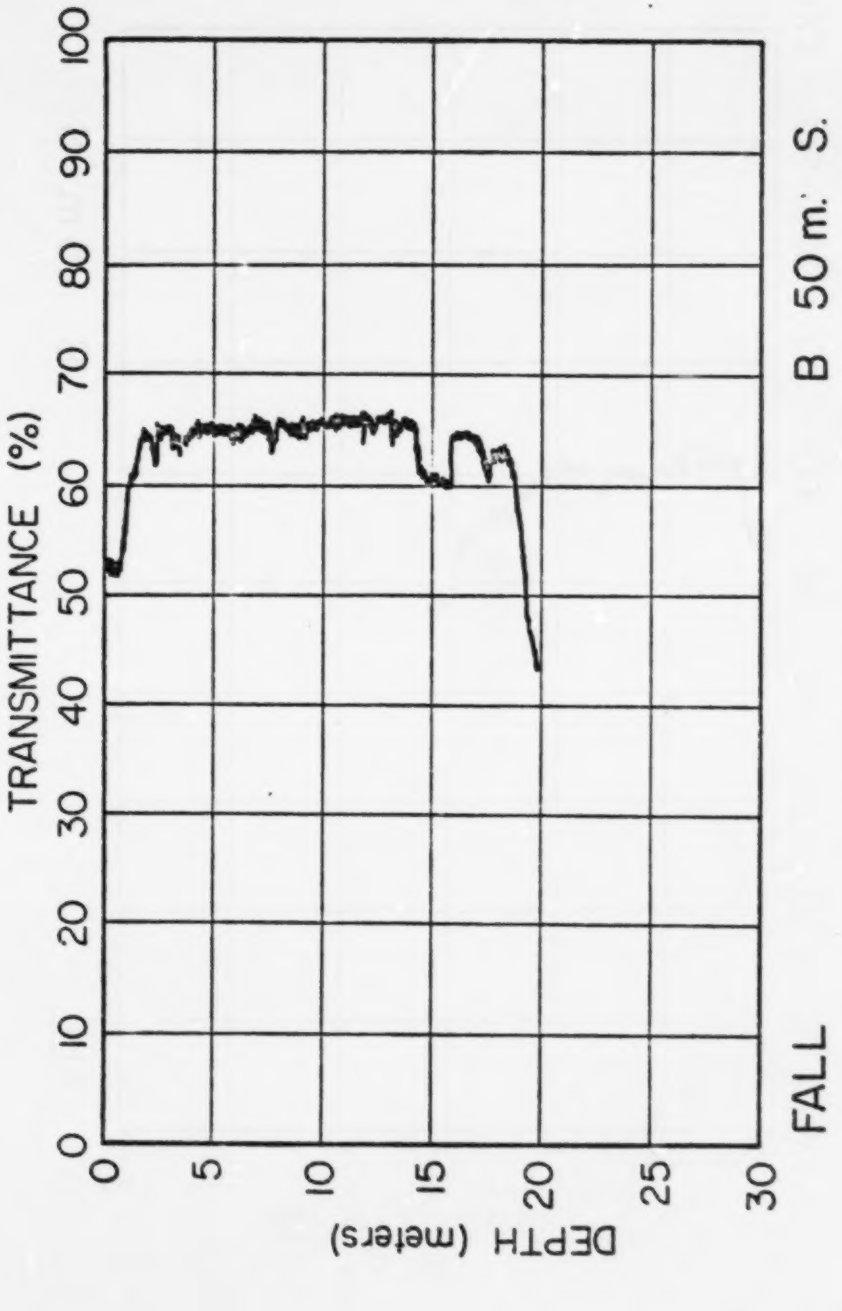
B 25 m. S.
FALL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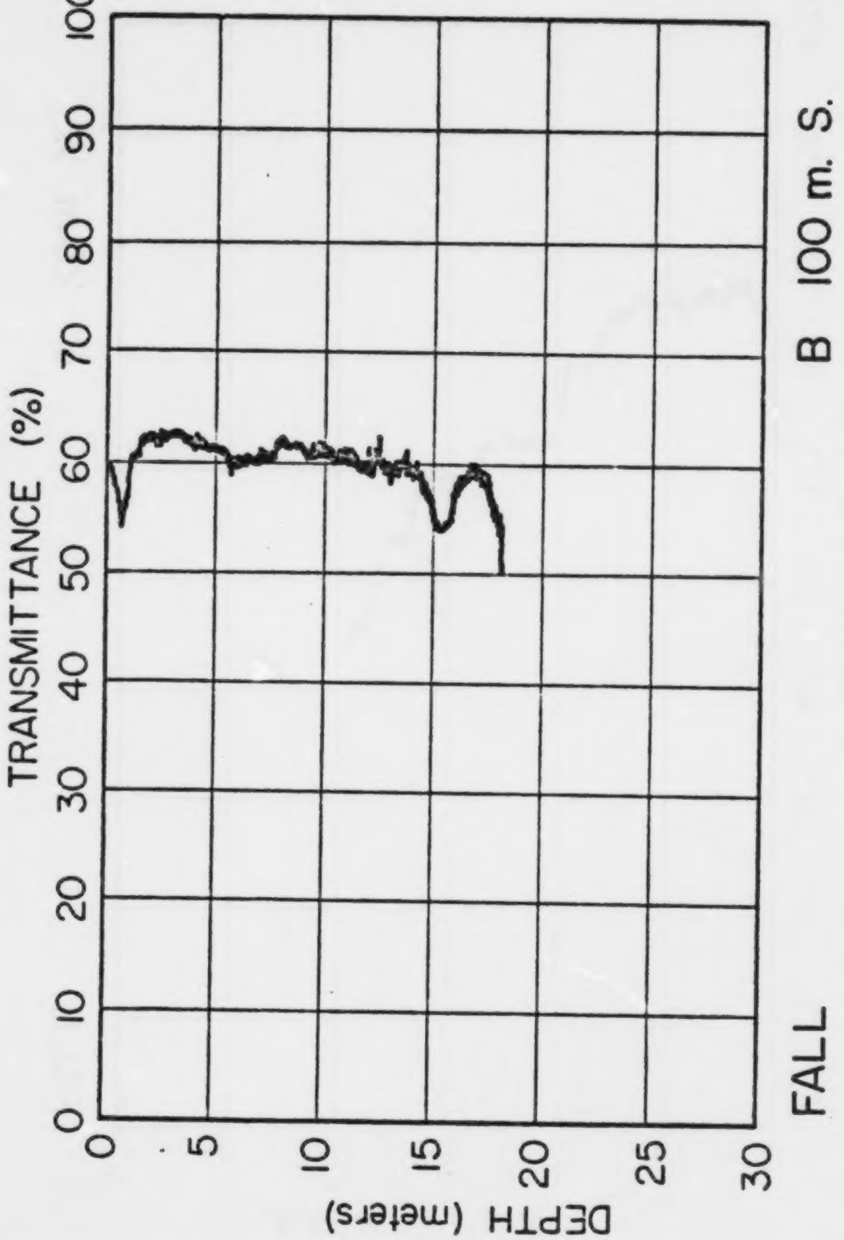
B 50 m. S.
FALL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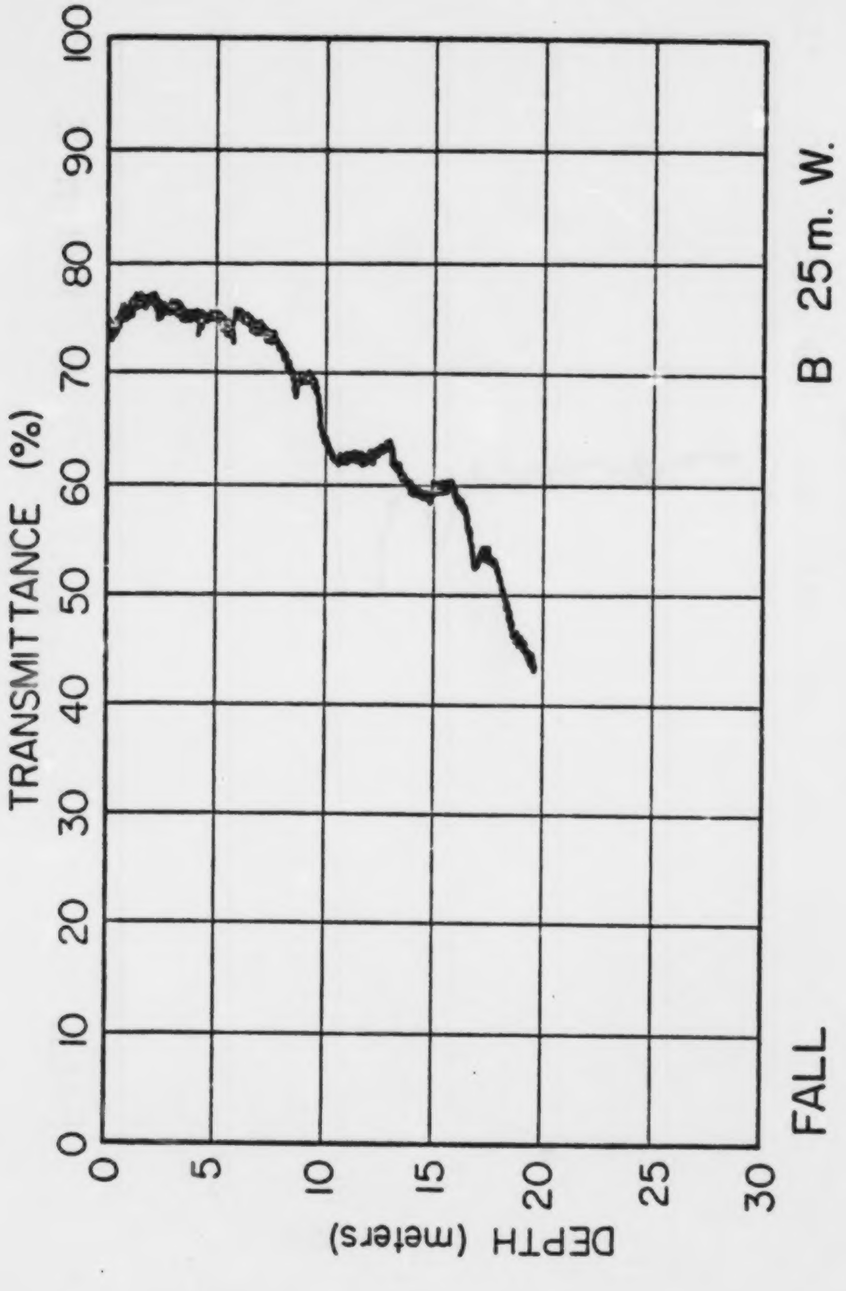
B 100 m. S.
FALL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DEPTH (meters)
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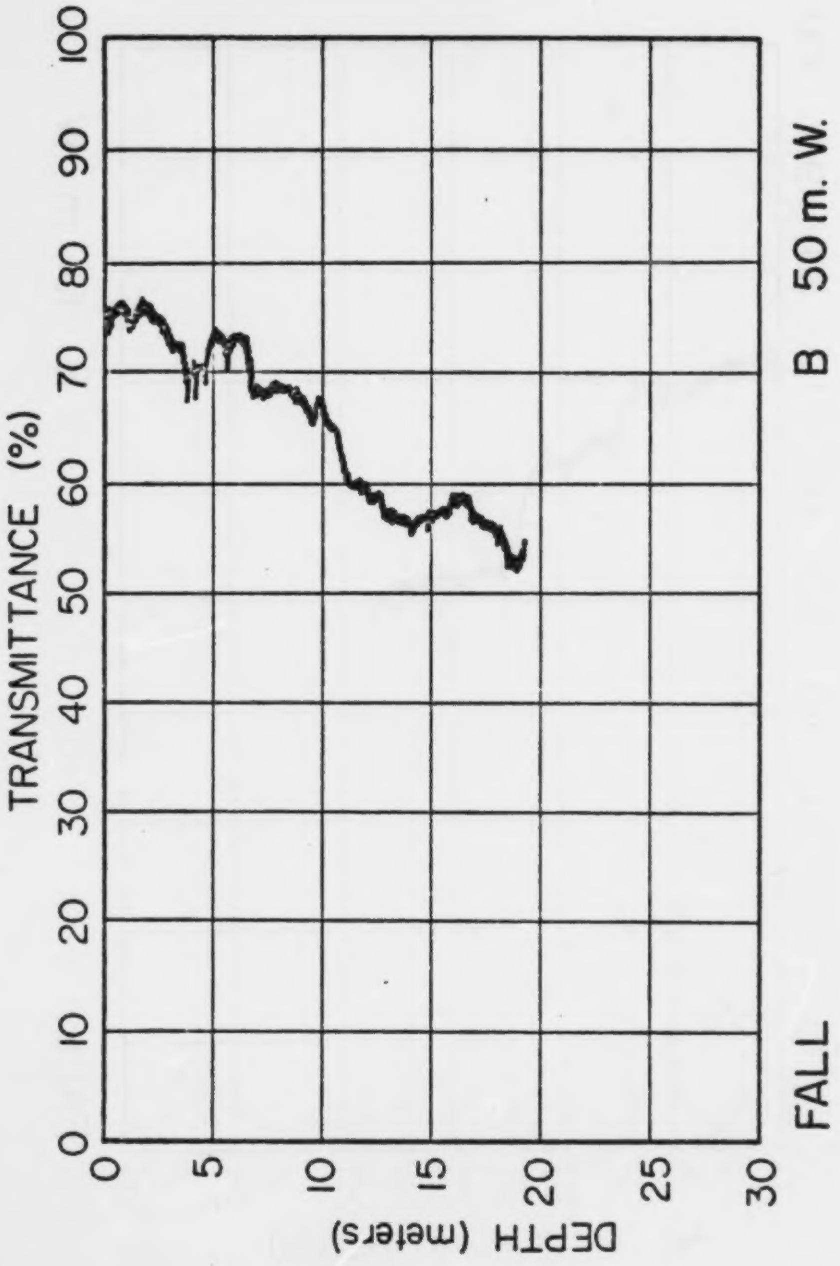
FALL
B 25 m. W.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DEPTH (meters)
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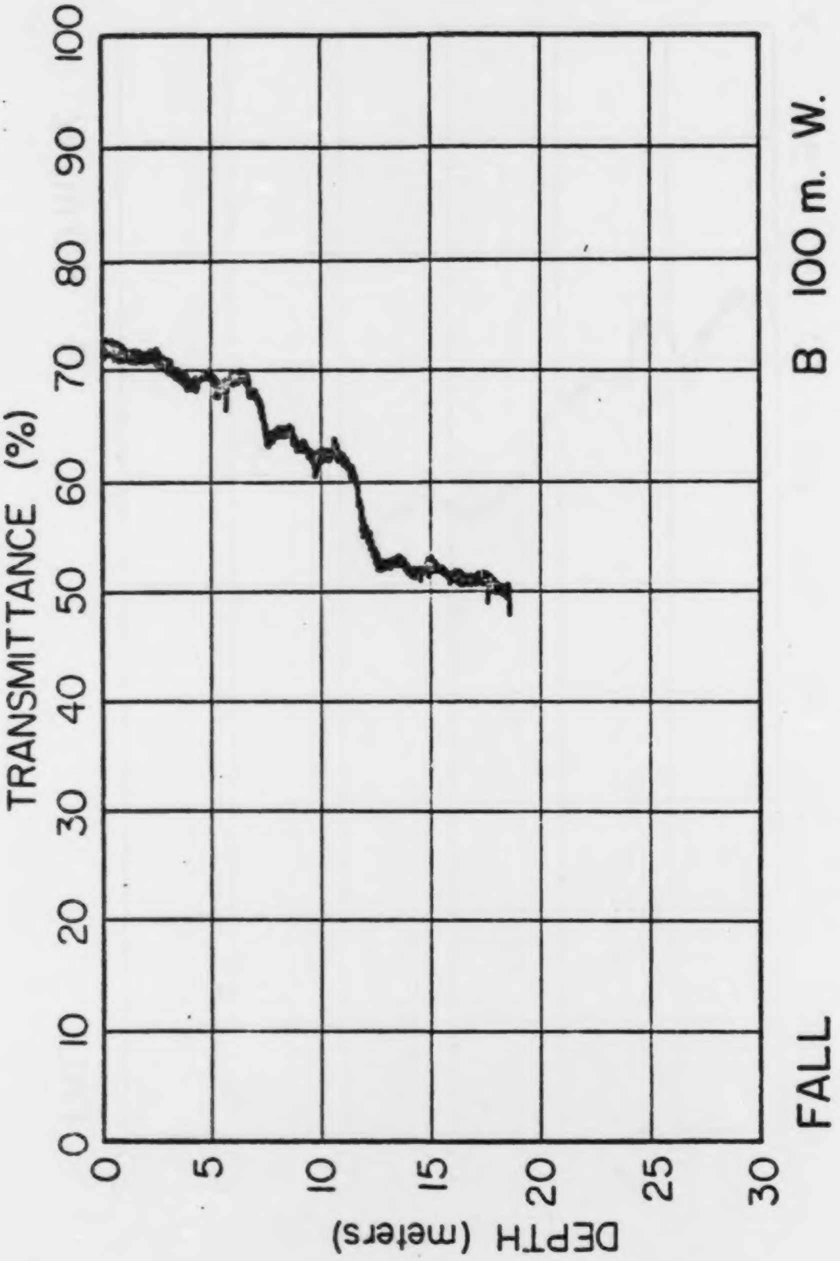
FALL
B 50 m. W.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DEPTH (meters)
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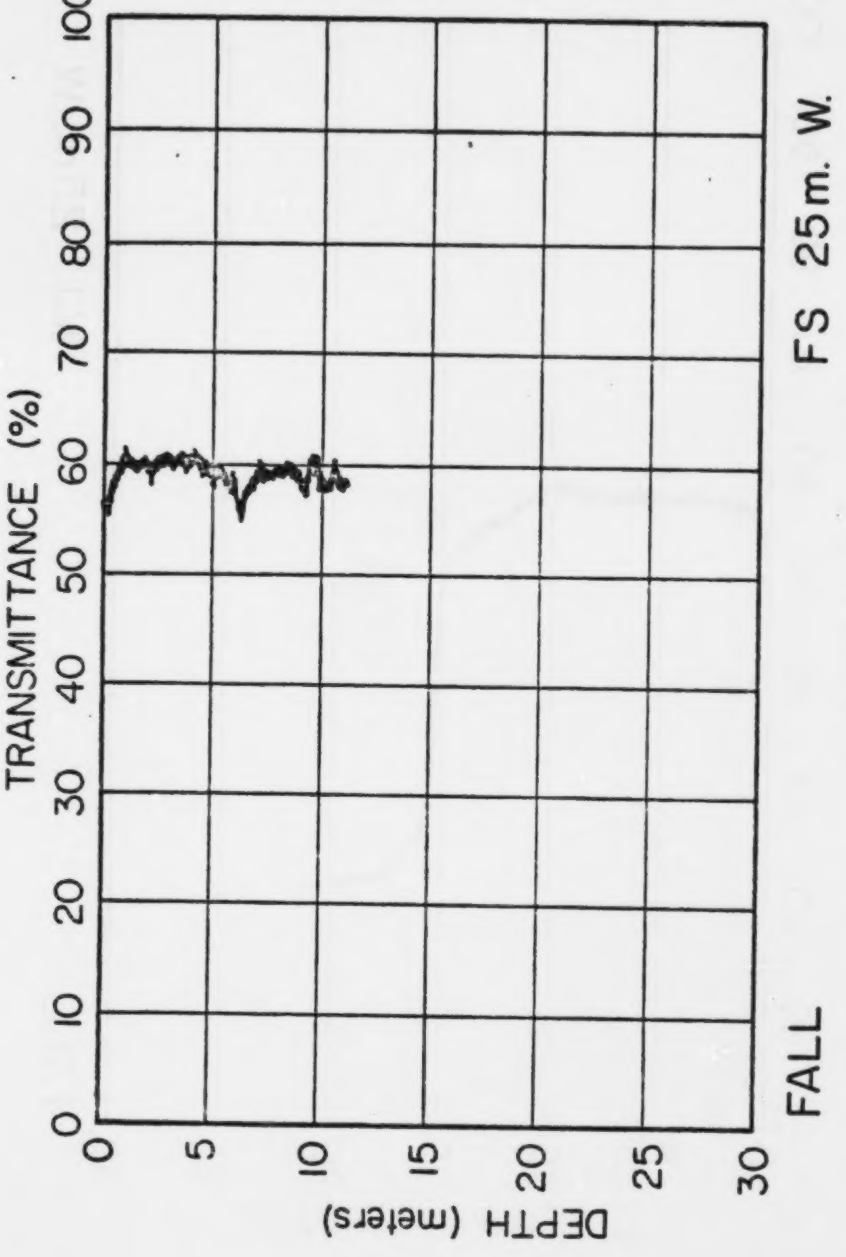
B 100 m. W.
FALL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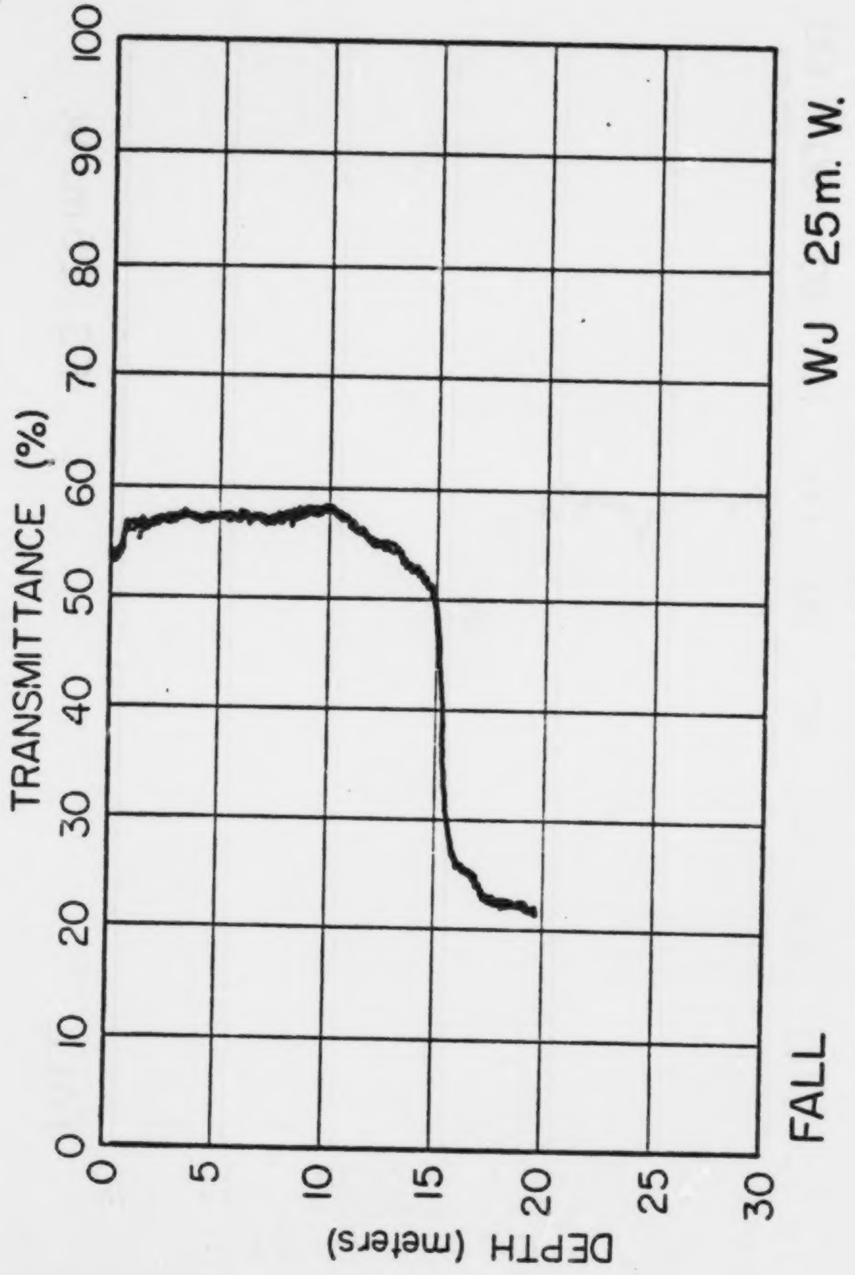
FALL

FS 25 m. W.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DEPTH (meters)
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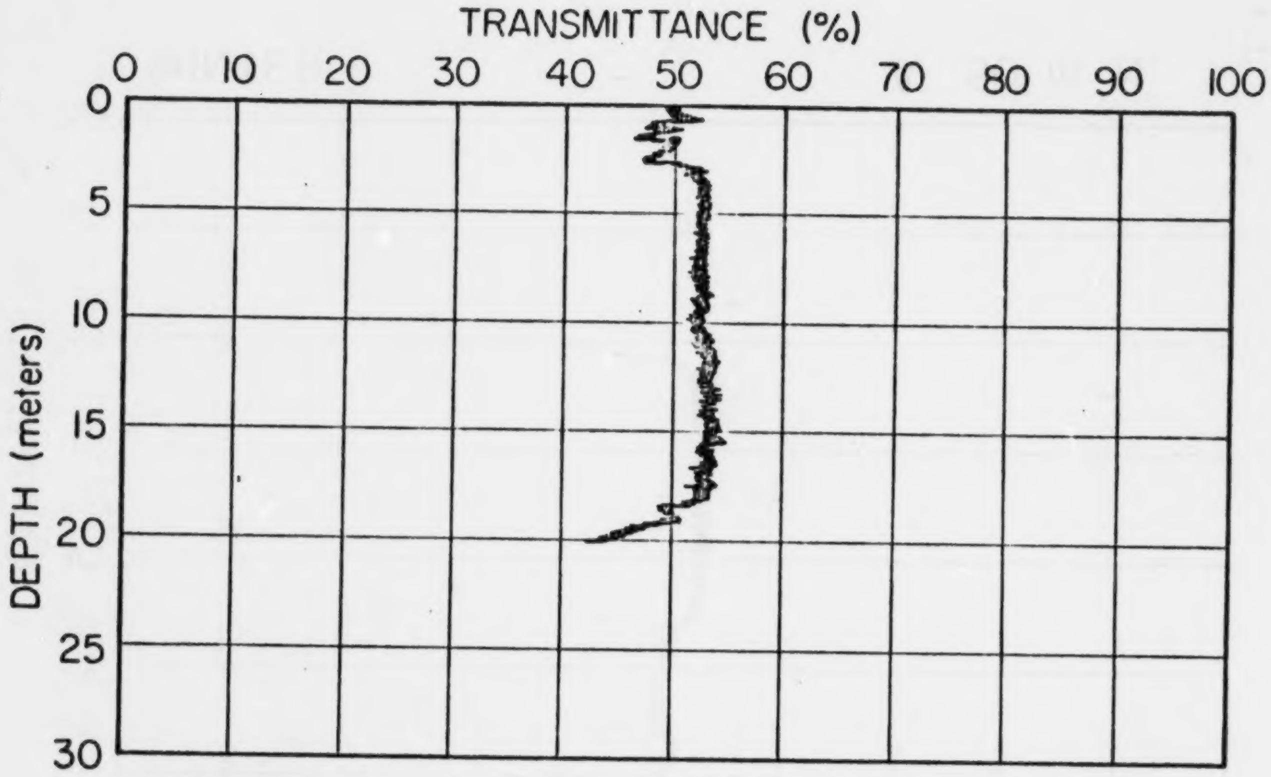
WJ 25m. W.
FALL

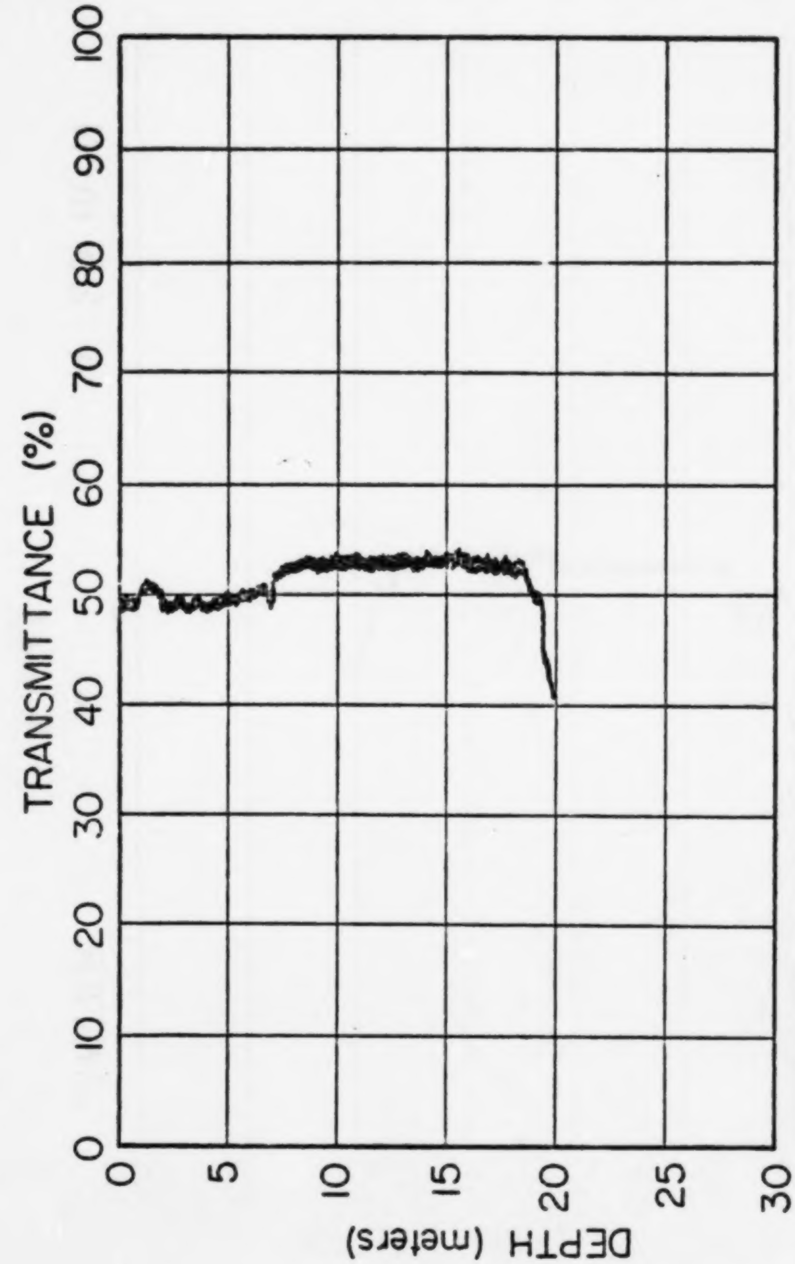


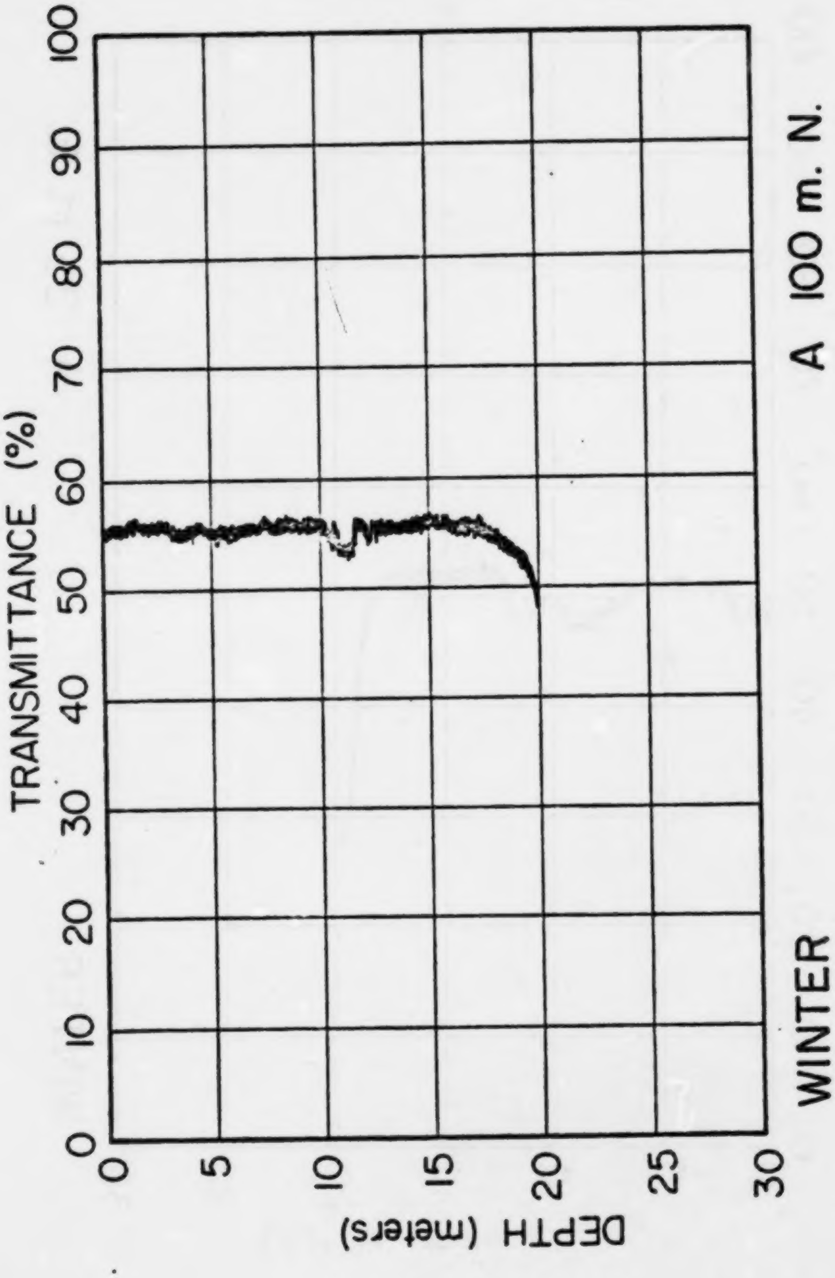
WINTER

A 25 m. N.

WINTER

A 50 m. N.

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DEPTH (meters)
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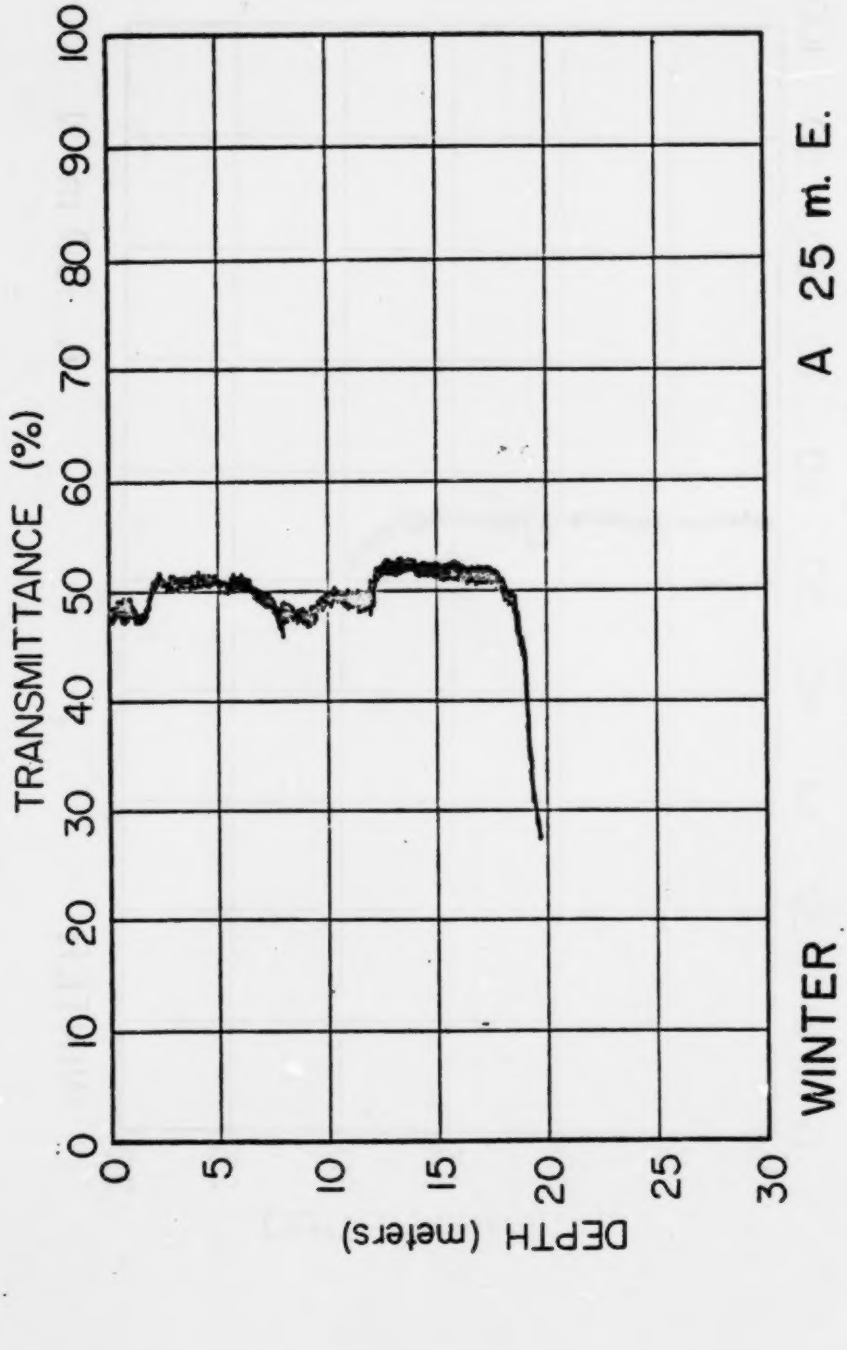
WINTER
A 100 m. N.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DEPTH (meters)
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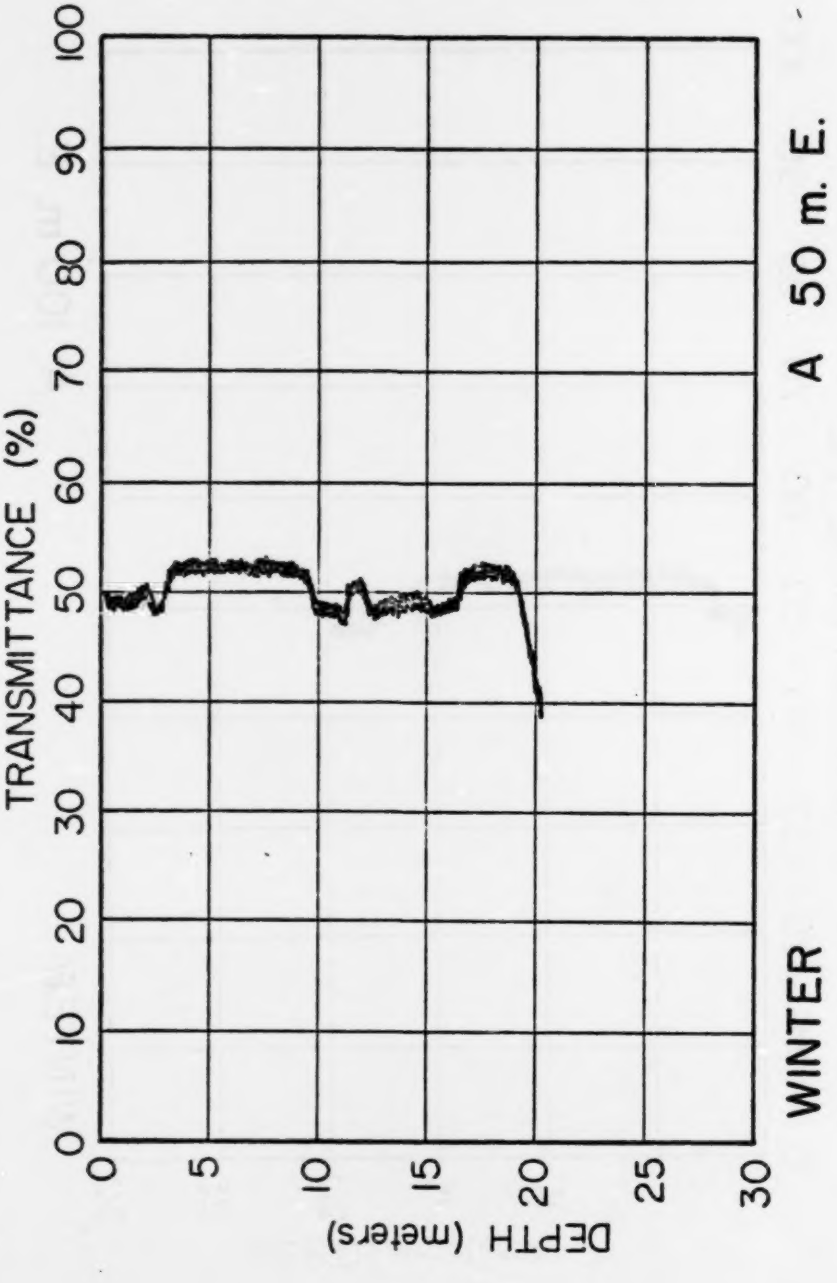
A 25 m. E.
WINTER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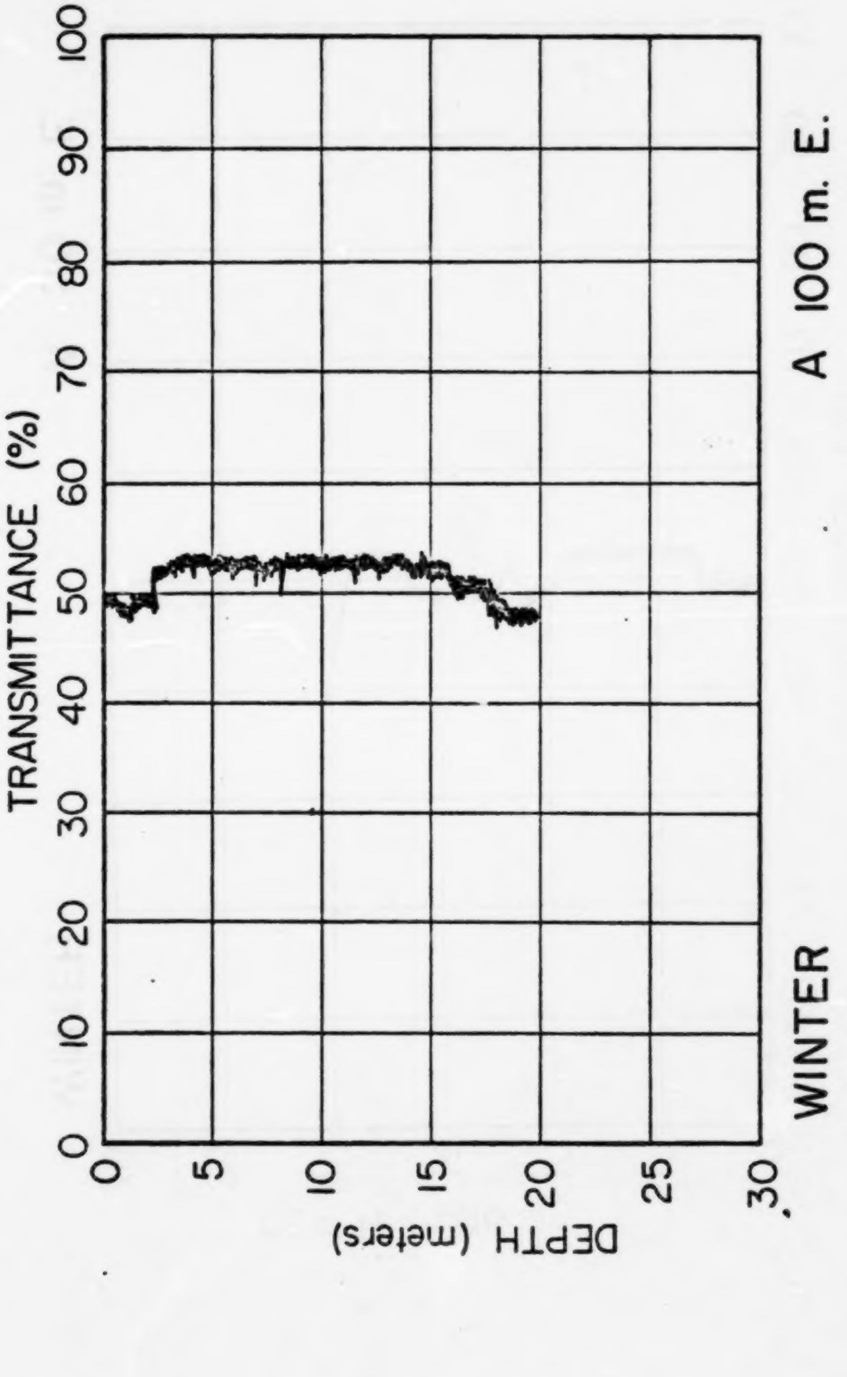
A 50 m. E.
WINTER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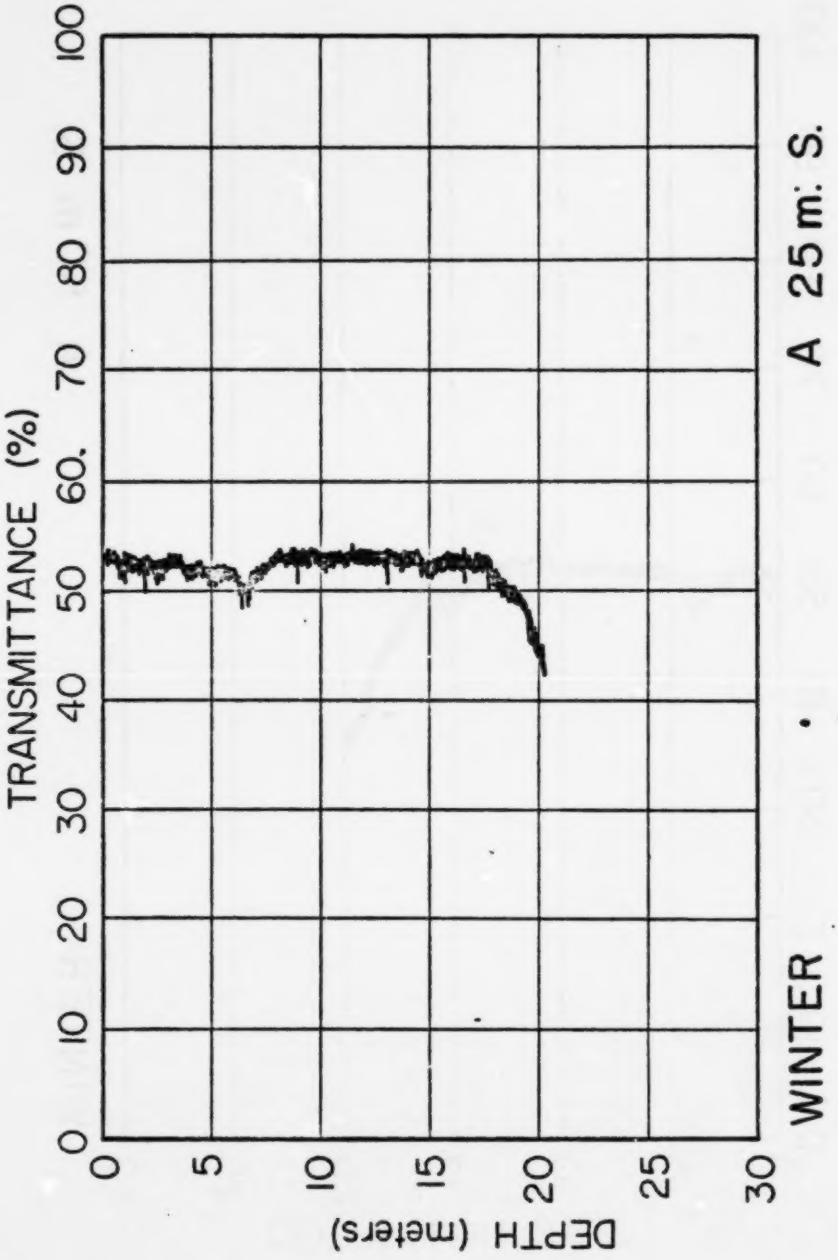
WINTER
A 100 m. E.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DEPTH (meters)
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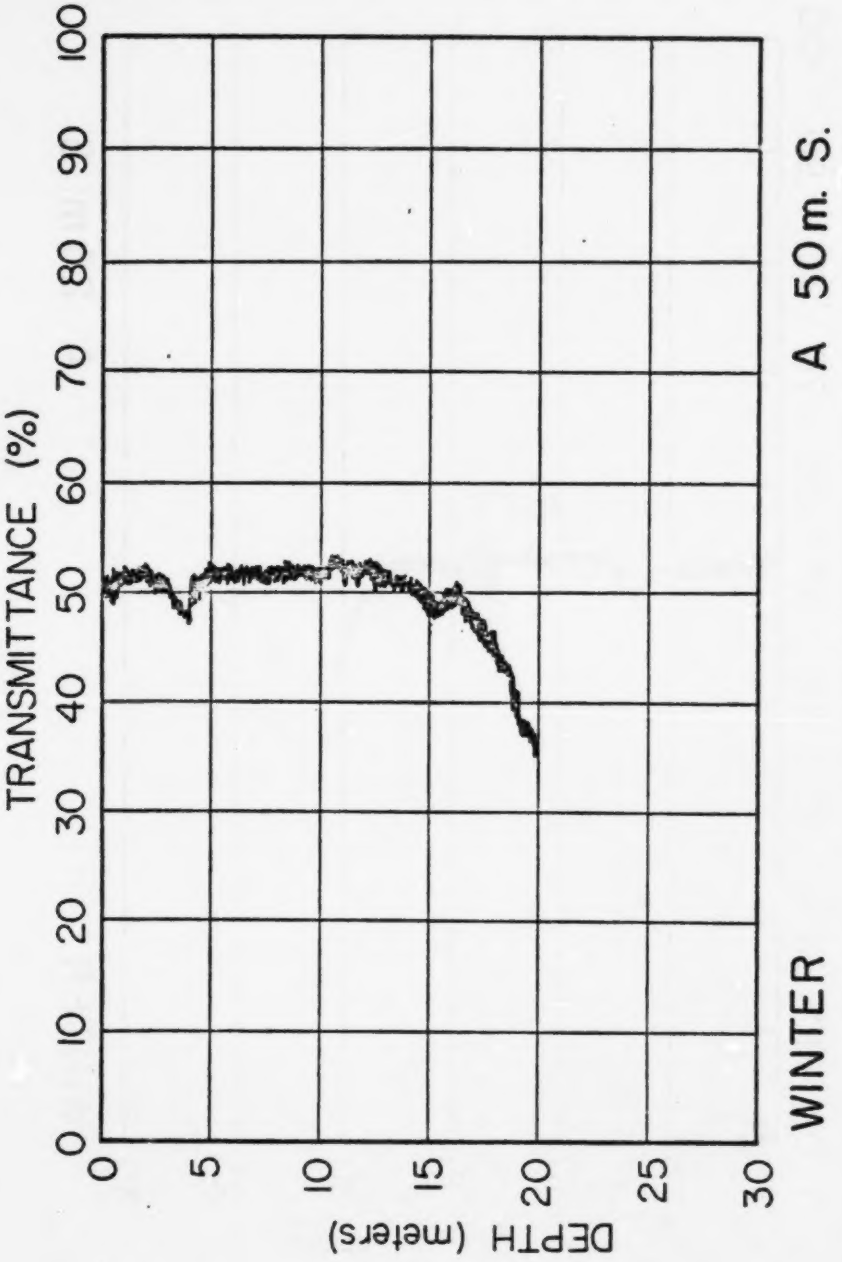
WINTER
A 25 m. S.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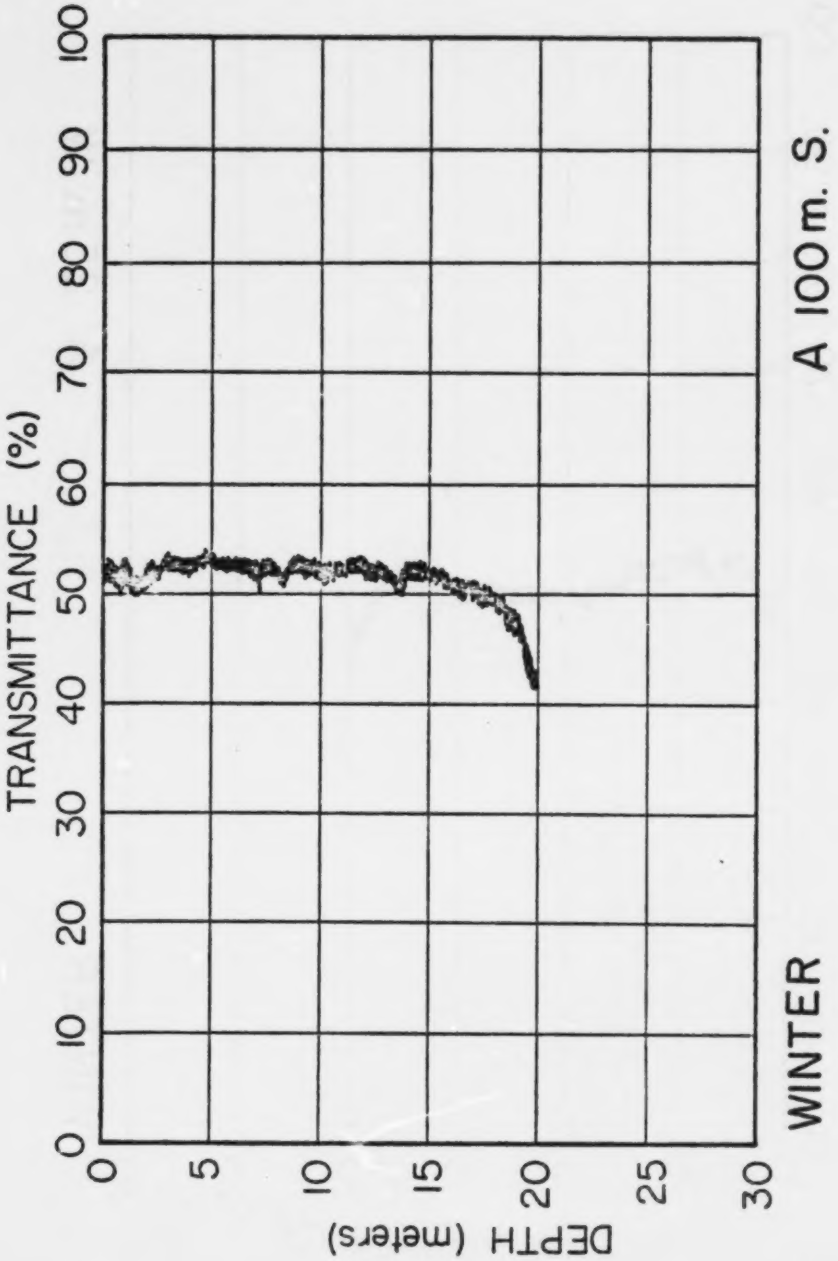
WINTER
A 50m. S.

TRANSMITTANCE (%)
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DEPTH (meters)
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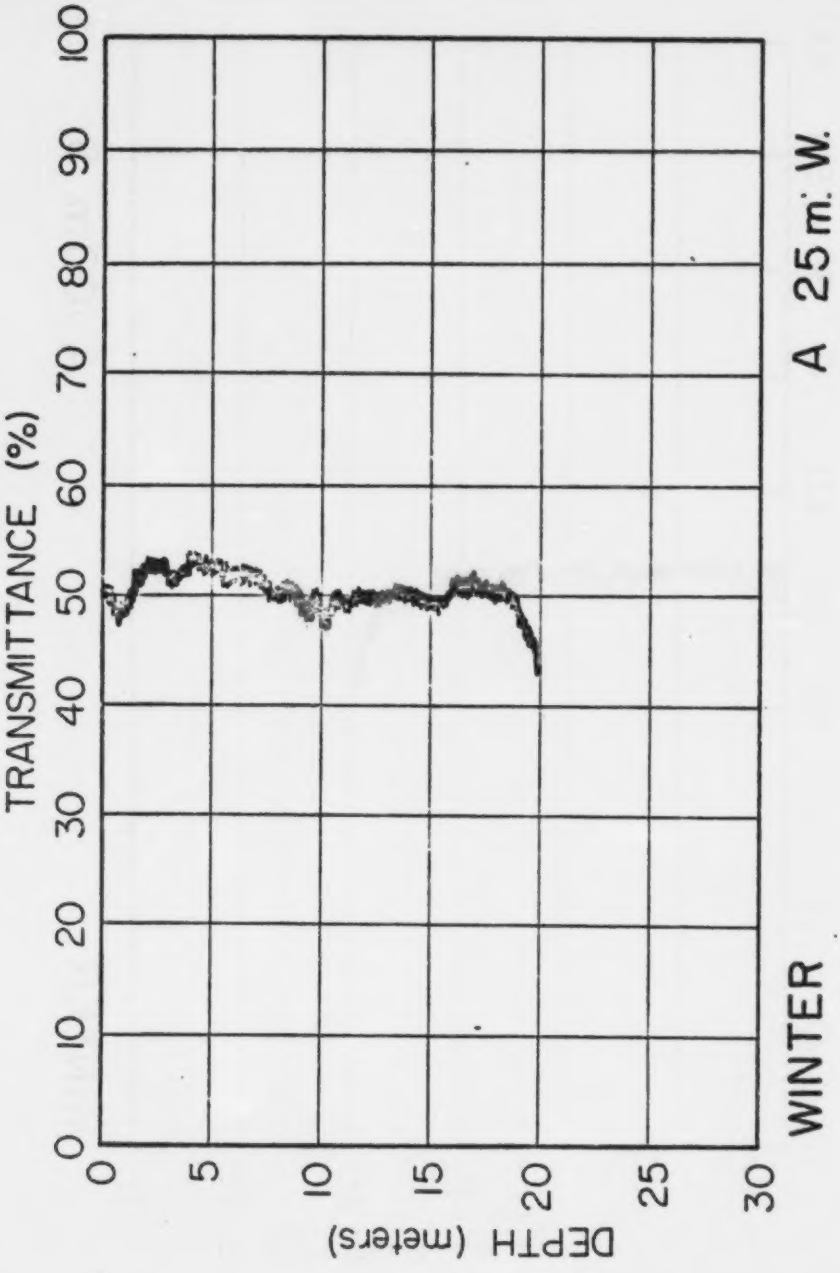
A 100 m. S.
WINTER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DEPTH (meters)
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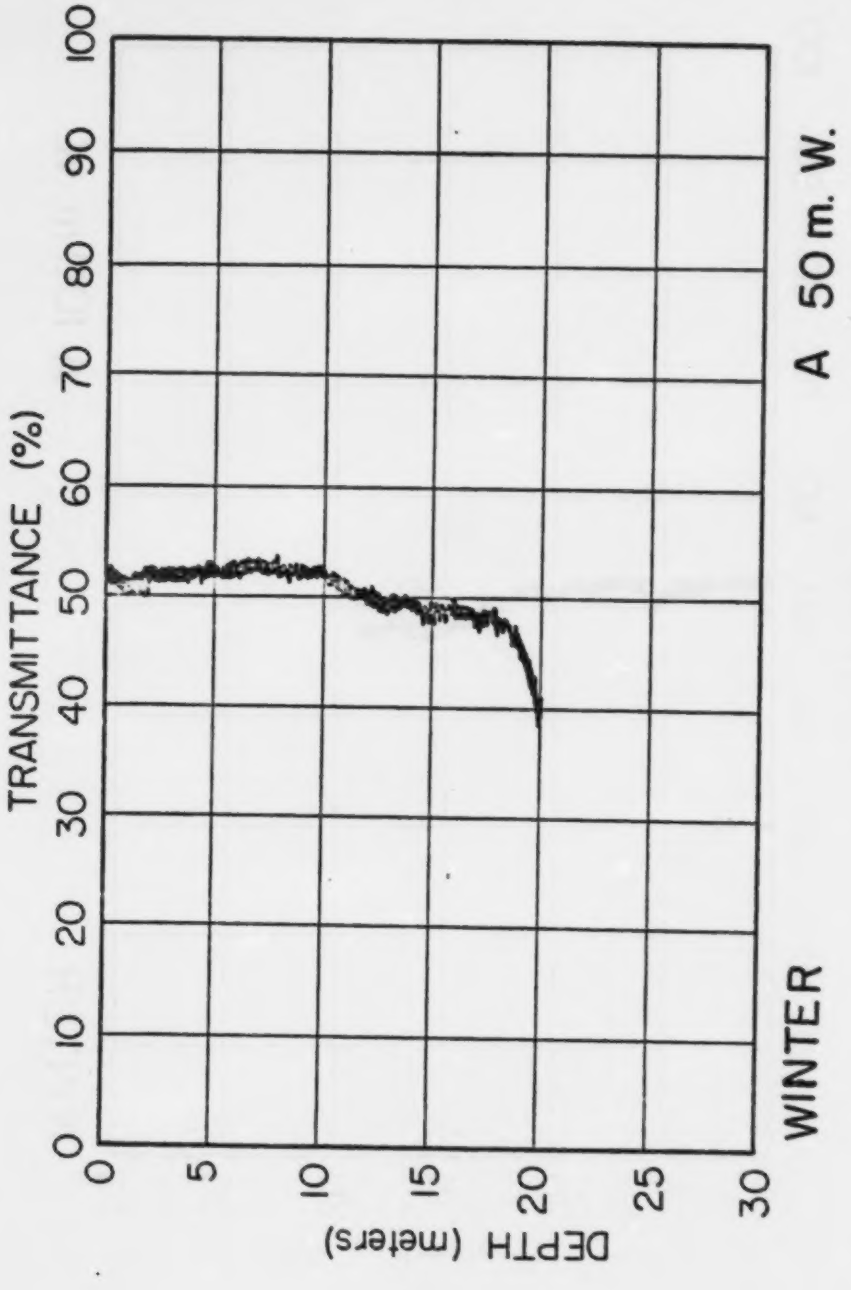
WINTER
A 25 m. W.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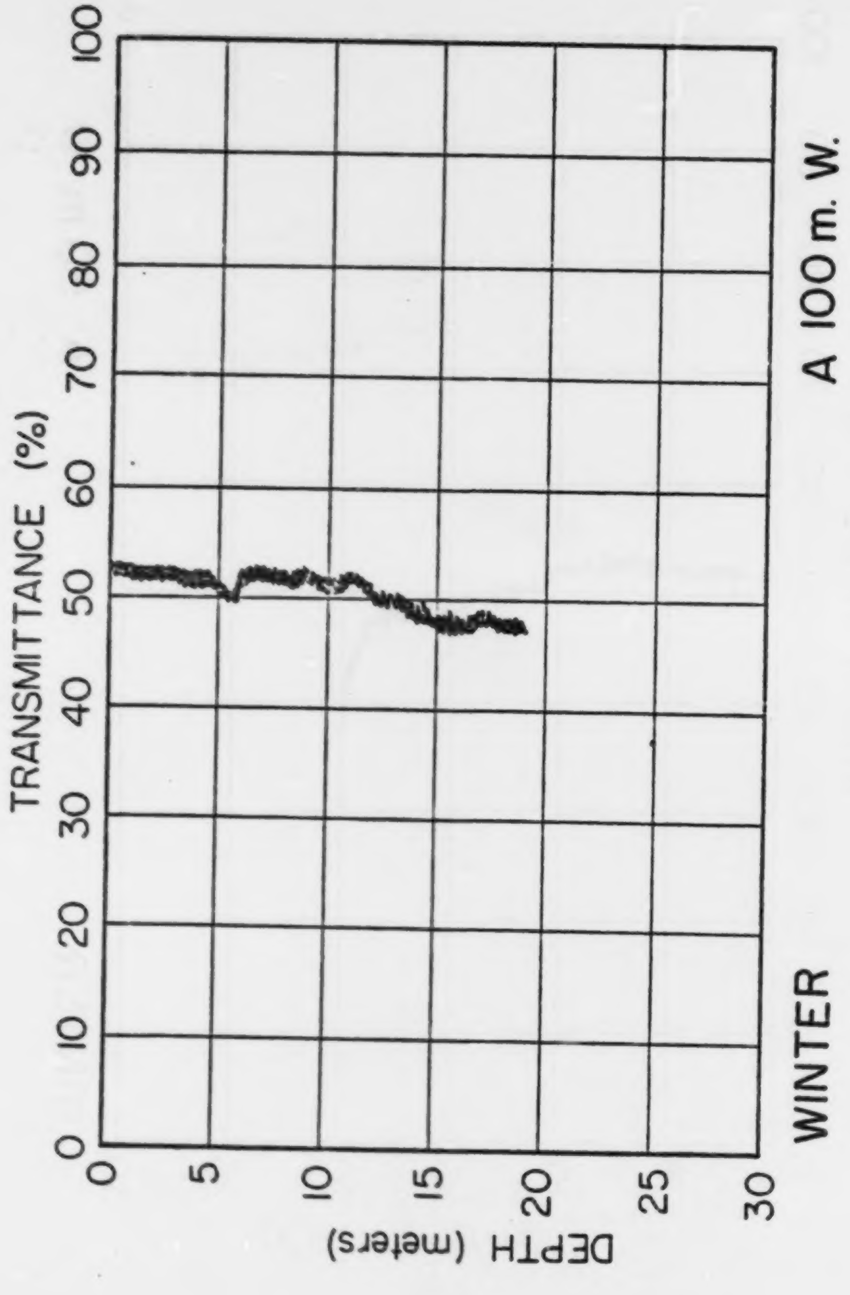
WINTER
A 50 m. W.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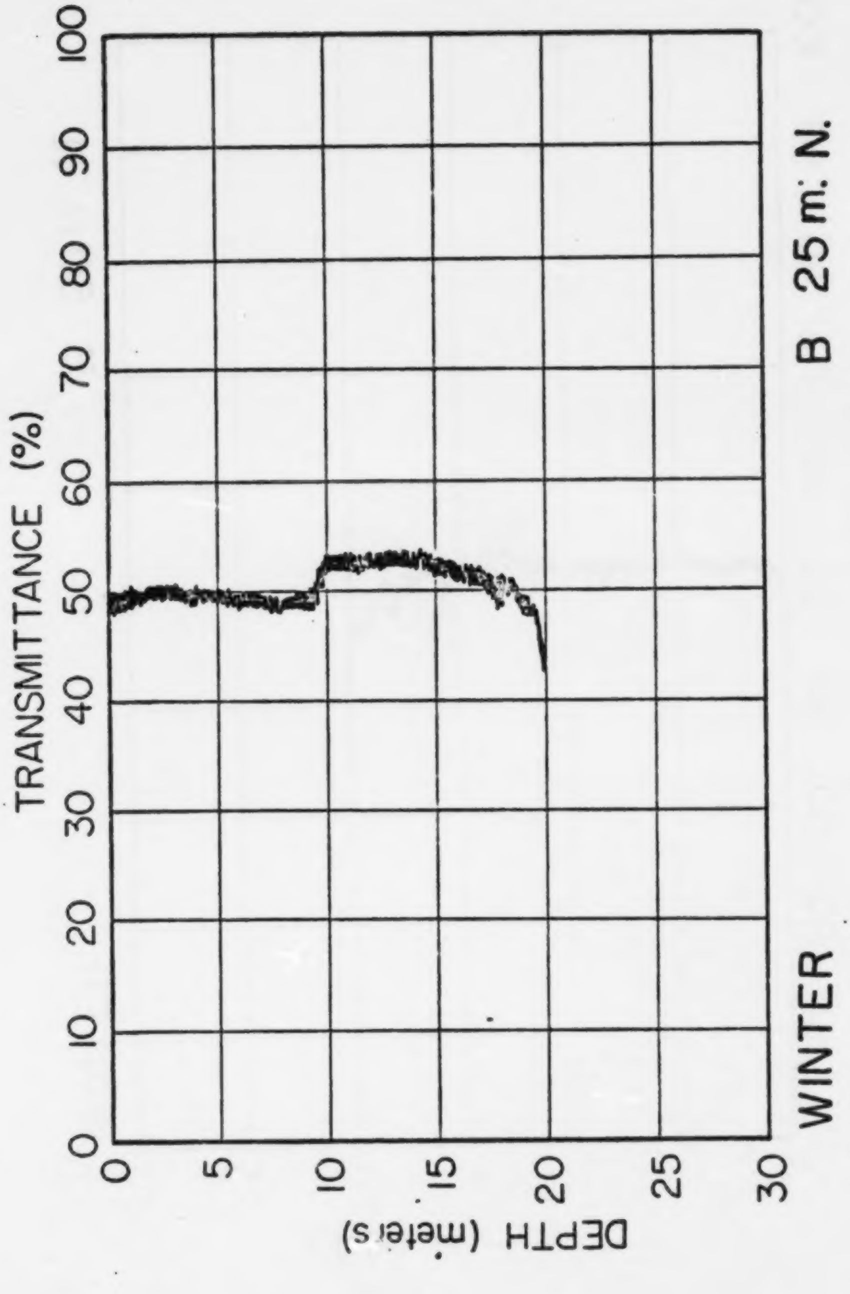
WINTER
A 100 m. W.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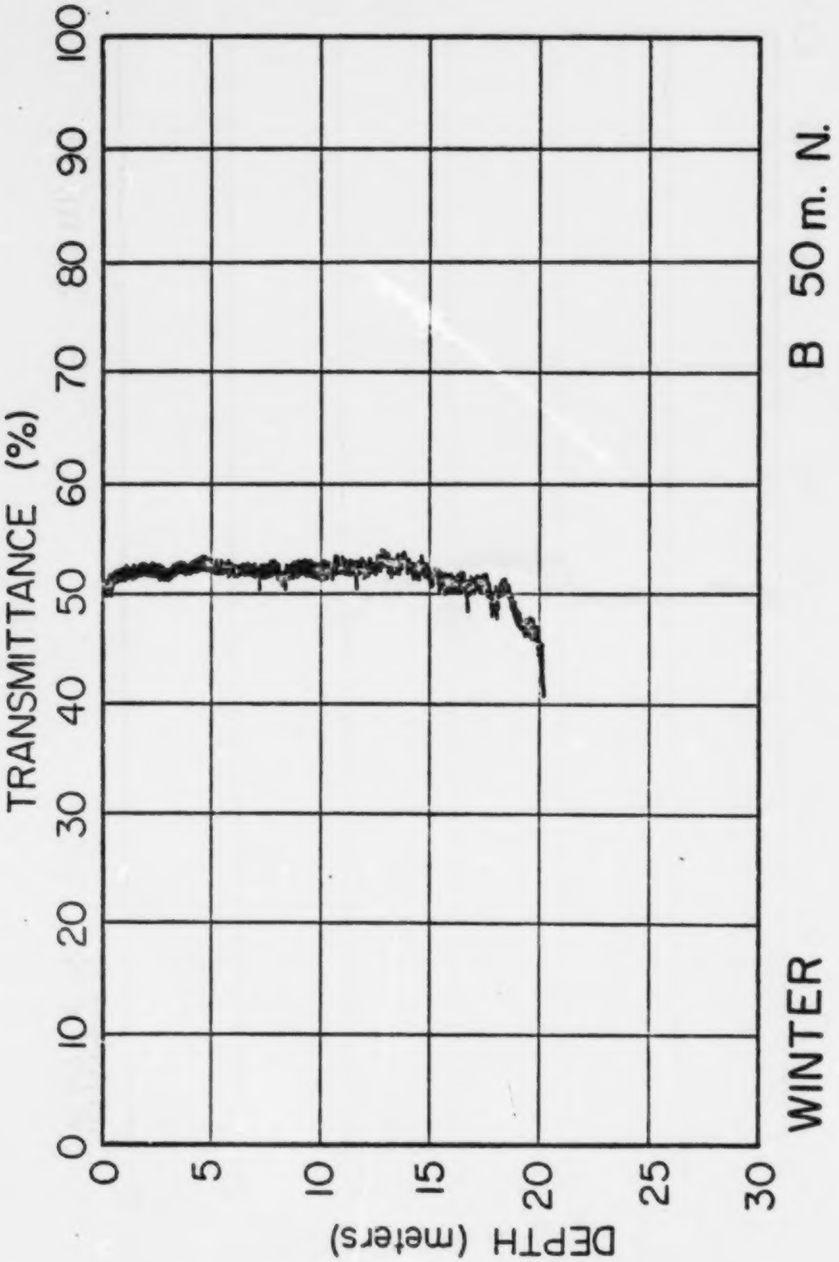
B 25 m: N.
WINTER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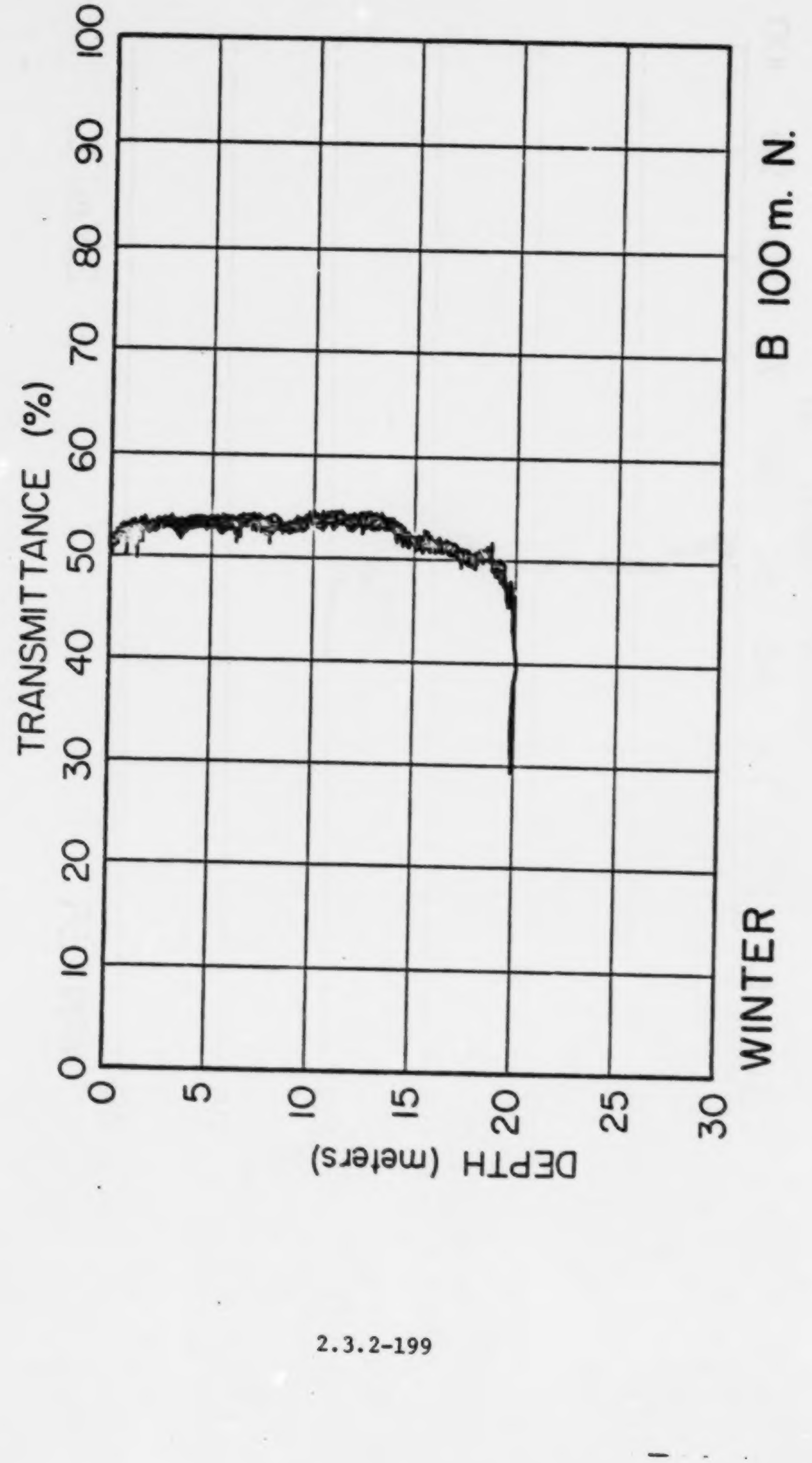
B 50 m. N.
WINTER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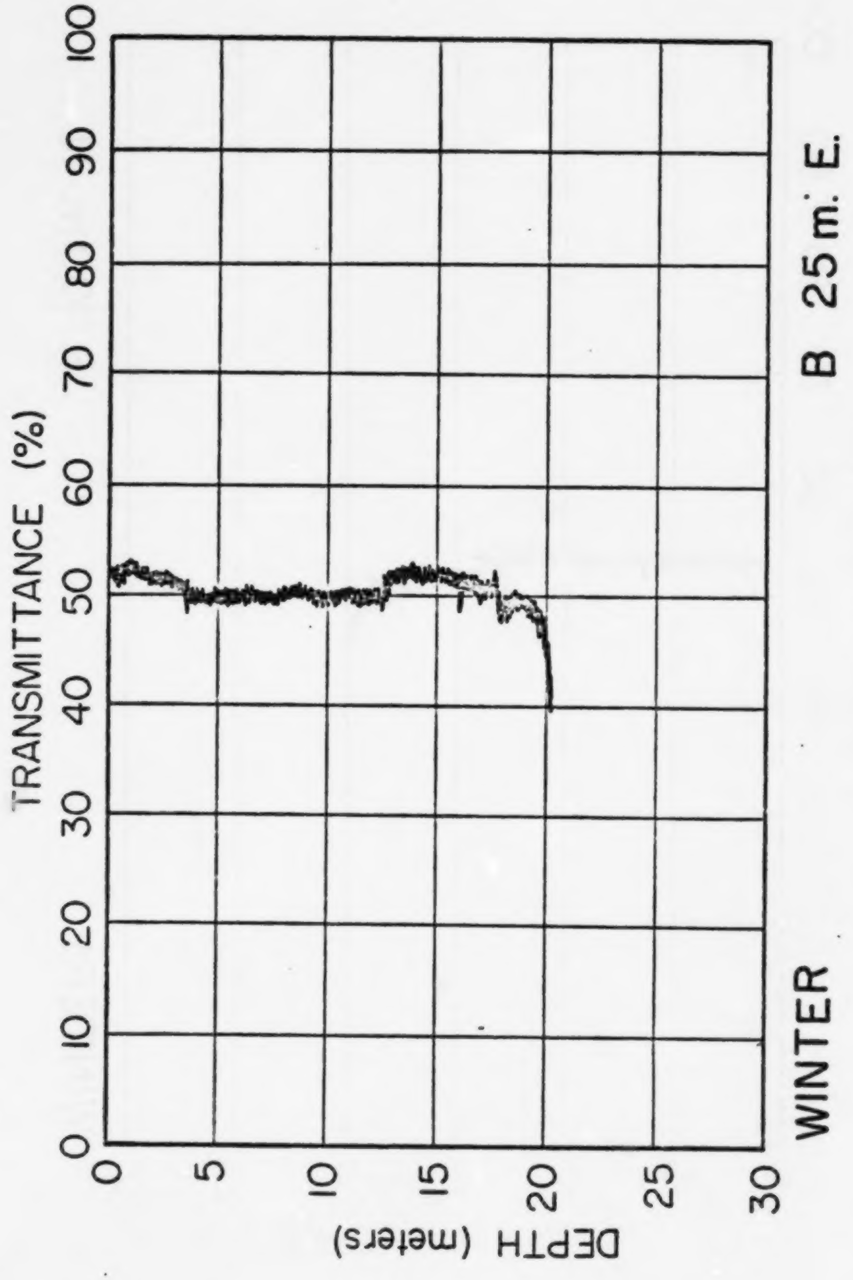
B 100 m. N.
WINTER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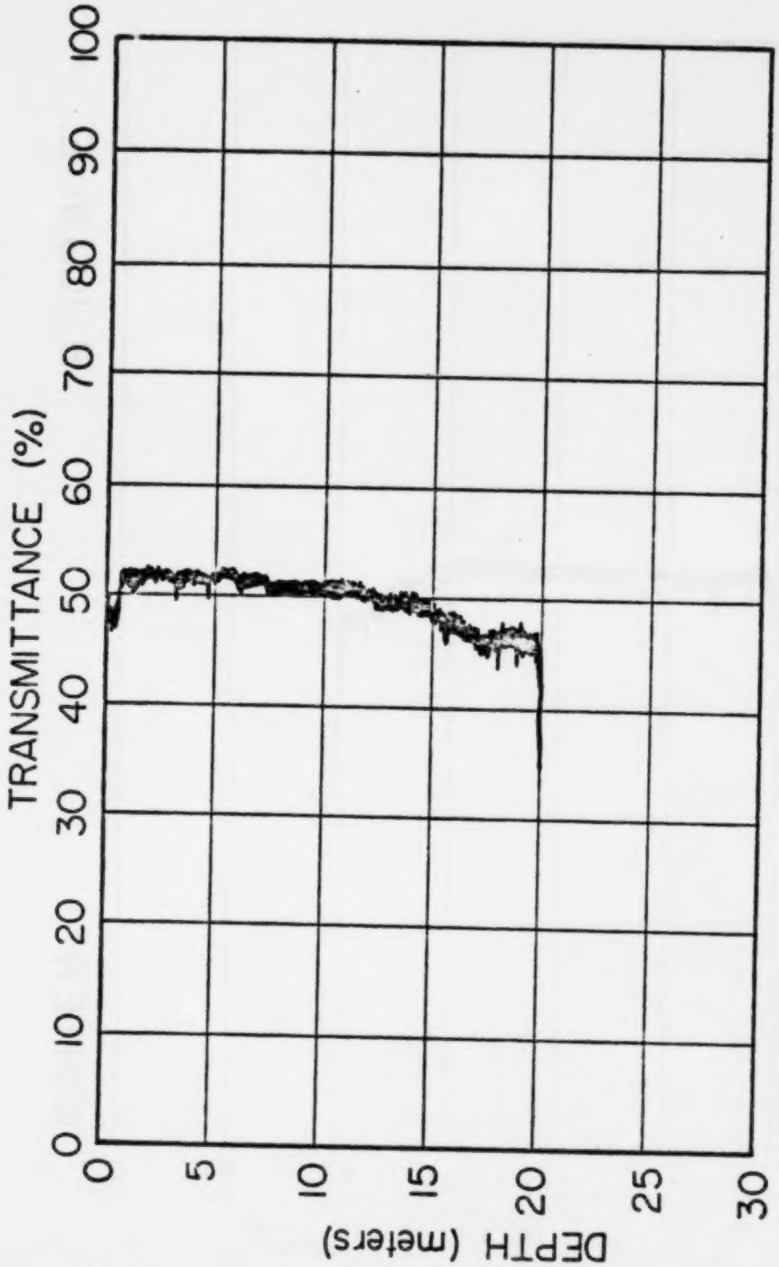
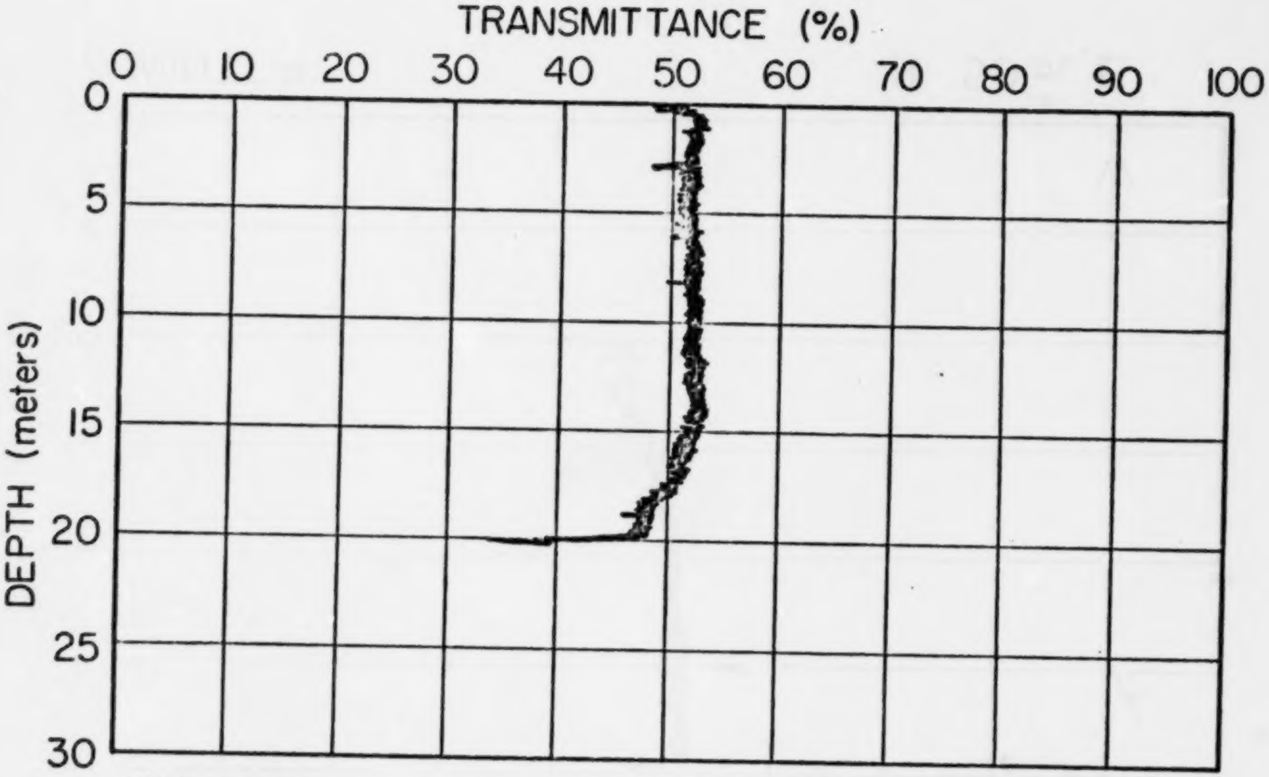
WINTER
B 25 m. E.



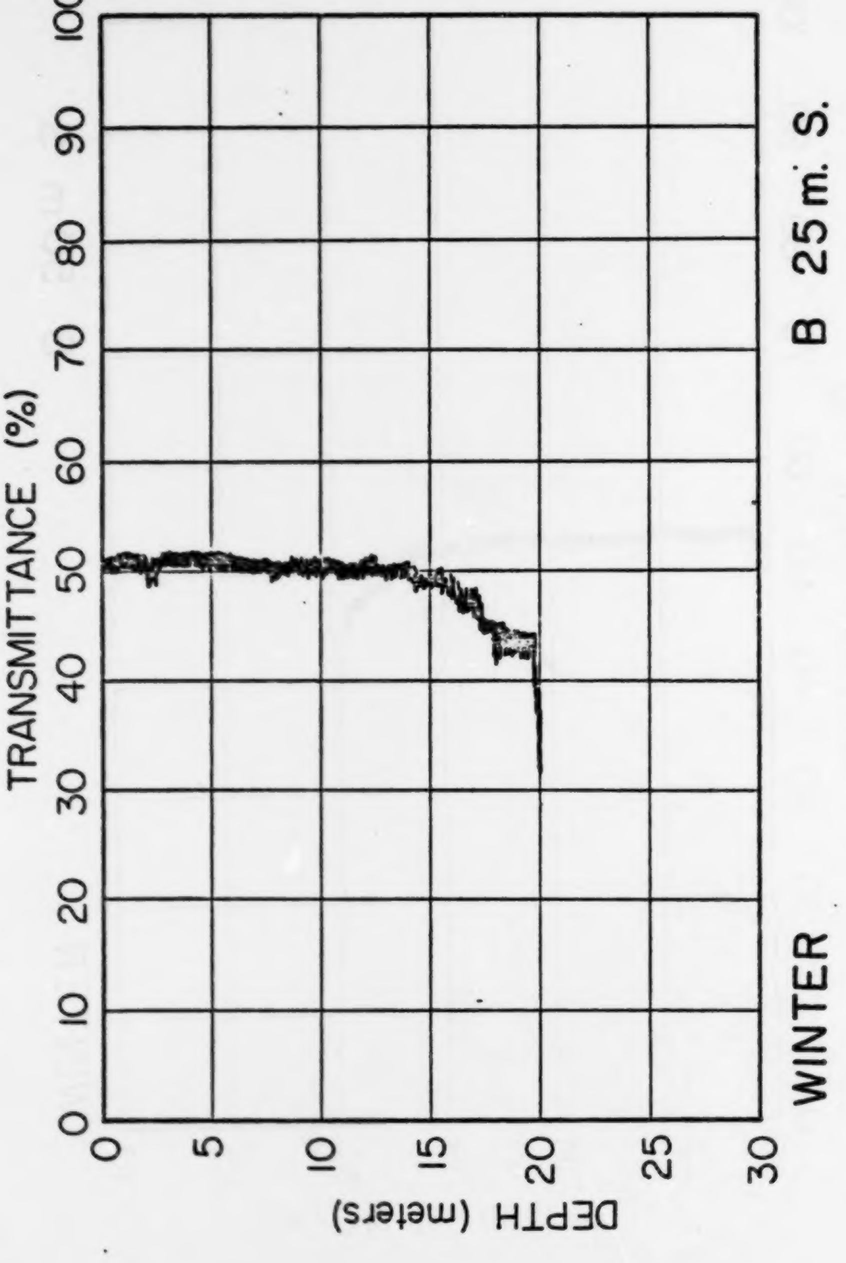
B 50 m. E.

WINTER



WINTER

B 100 m. E.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DEPTH (meters)
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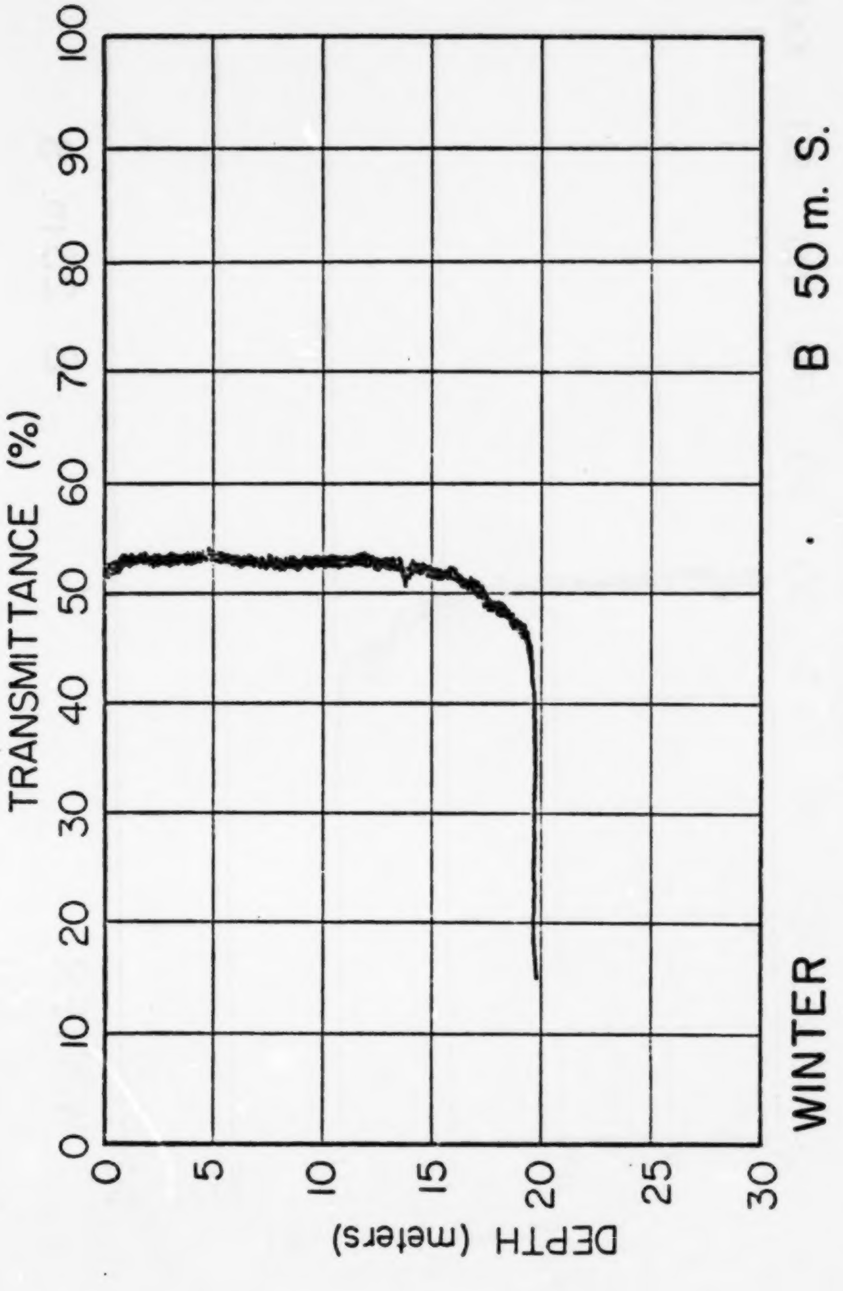
B 25 m. S.
WINTER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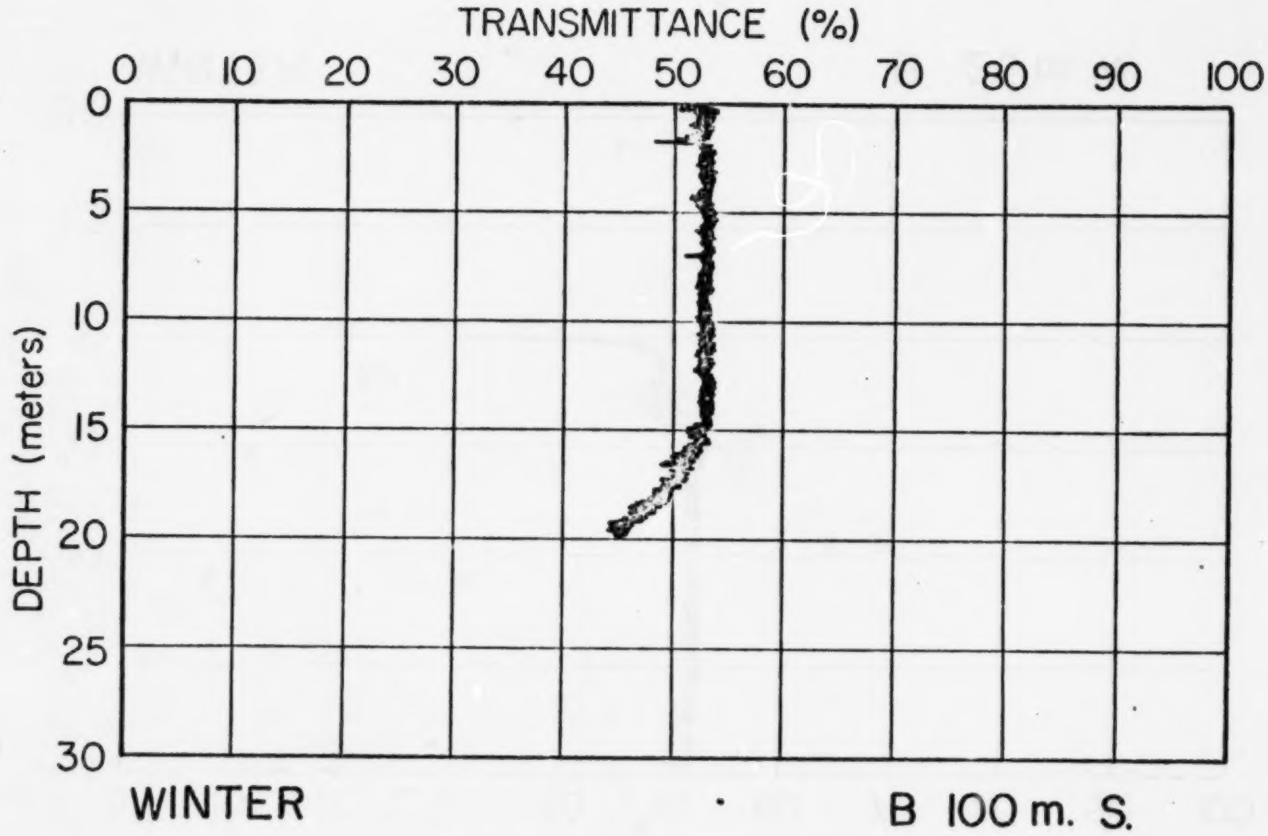
WINTER
B 50 m. S.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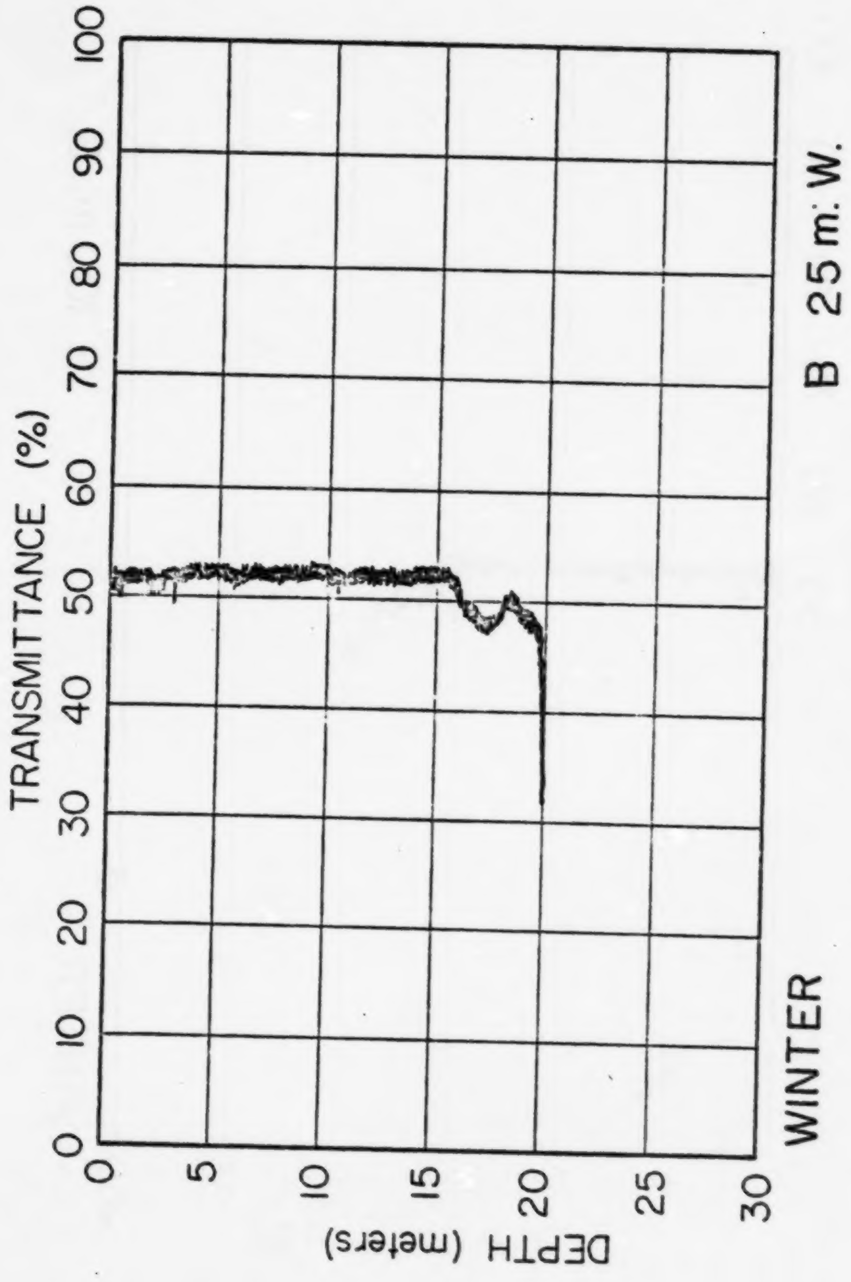
WINTER
B 100 m. S.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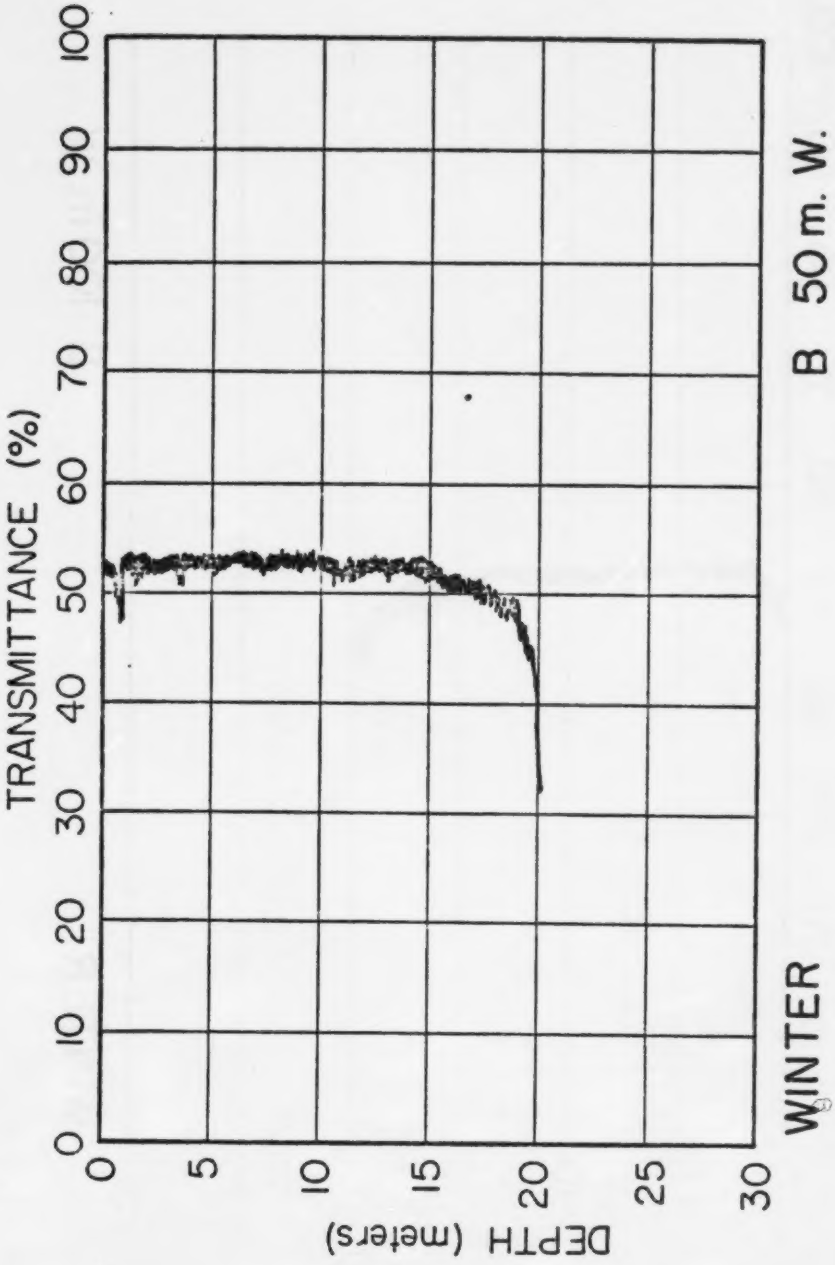
30
WINTER
B 25 m: W.


TRANSMITTANCE (%)
0
10
20
30
40
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60
70
80
90
100
DEPTH (meters)
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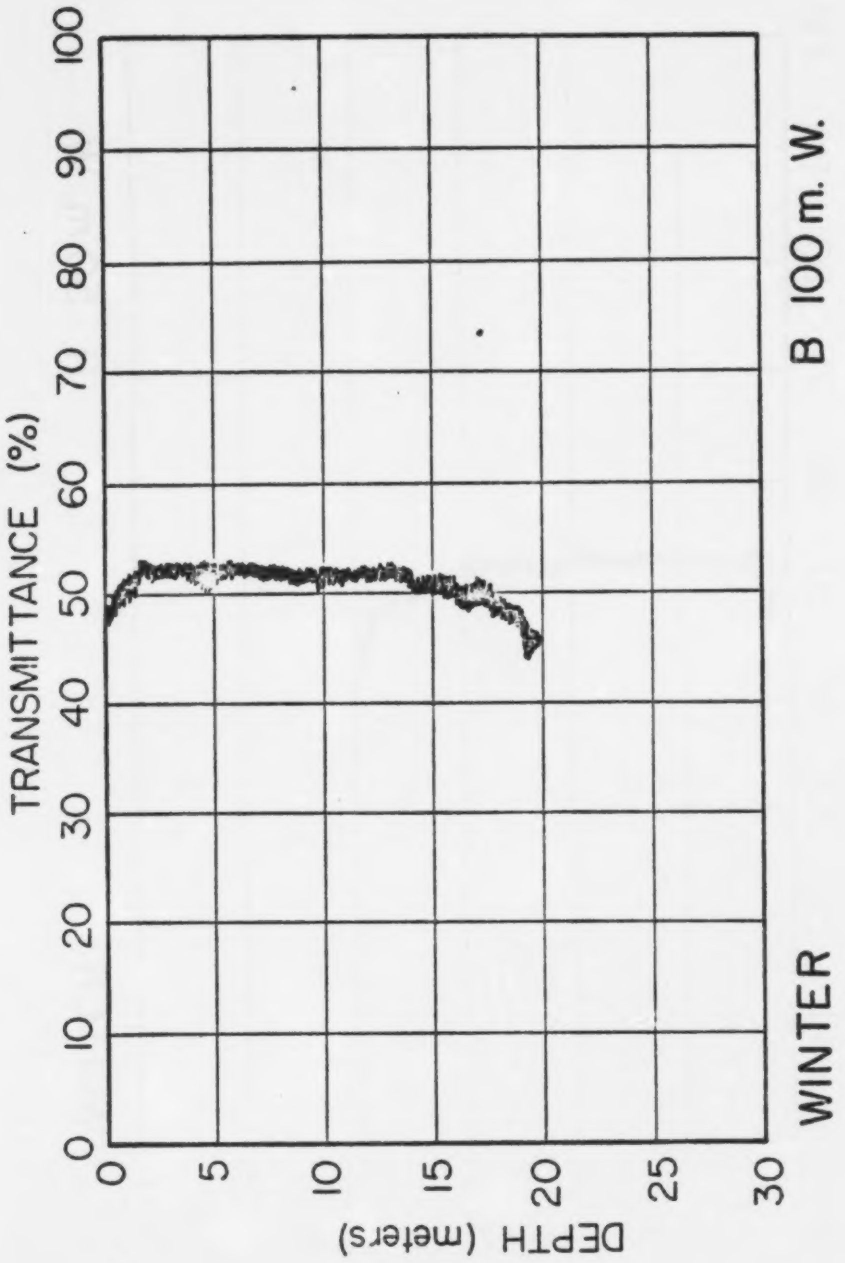
5
10
15
20
25
30
WINTER
B 50 m. W.


TRANSMITTANCE (%)
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20
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100
DEPTH (meters)
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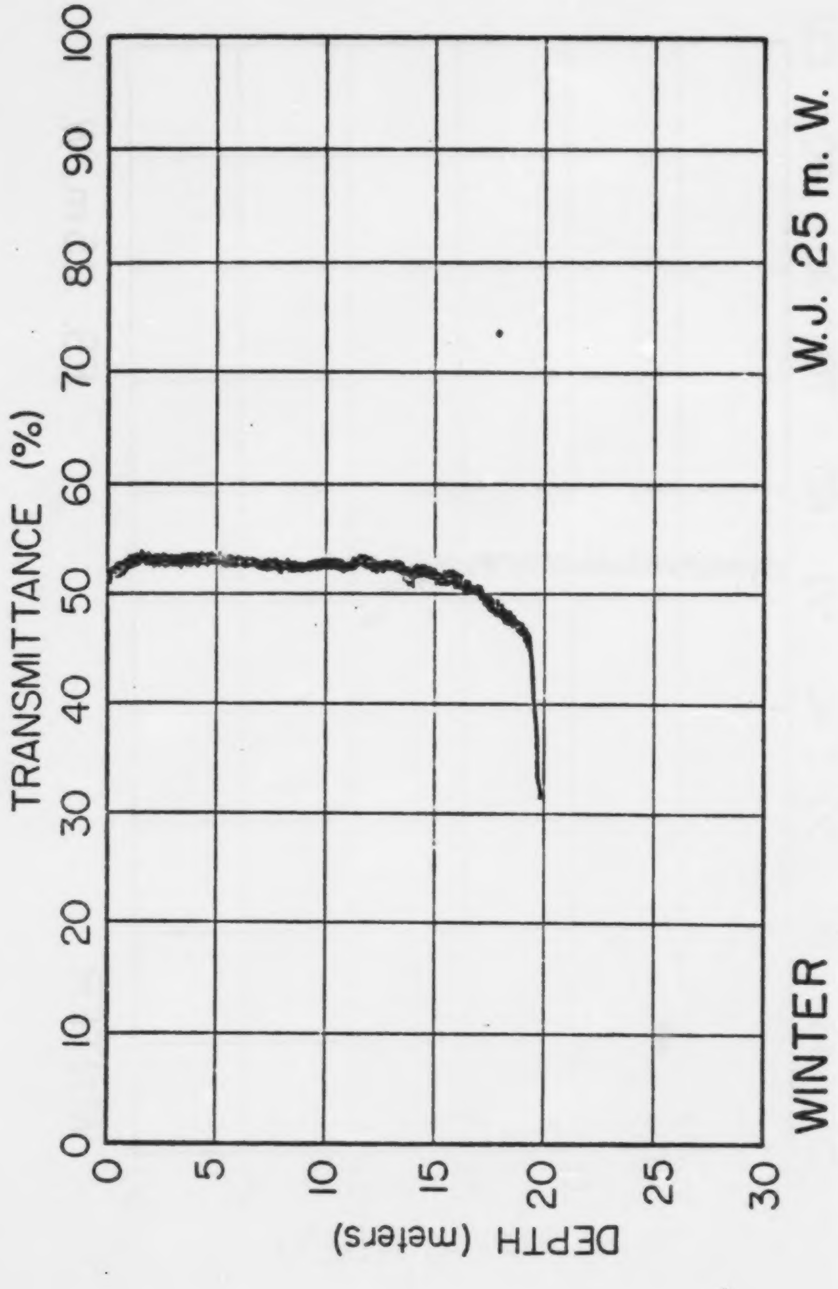
10
15
20
25
30
WINTER
B 100 m. W.


TRANSMITTANCE (%)
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20
30
40
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70
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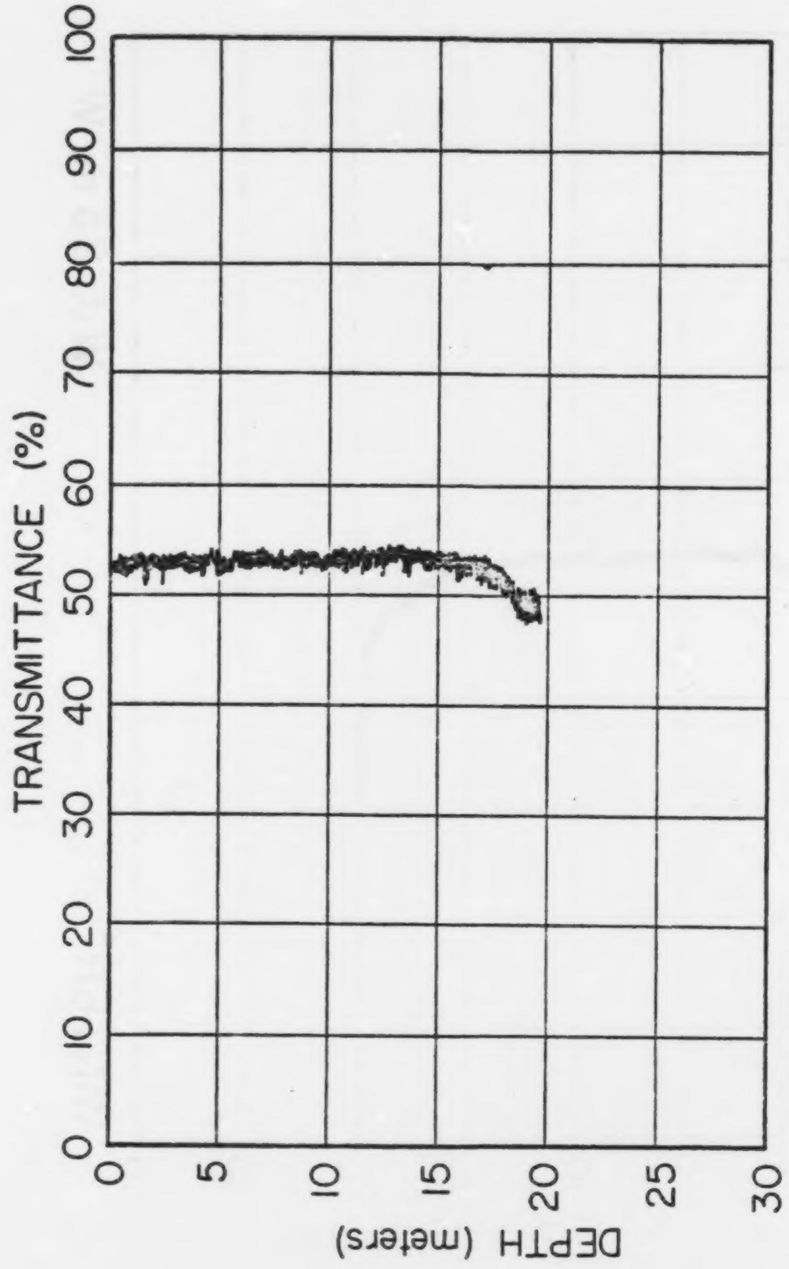
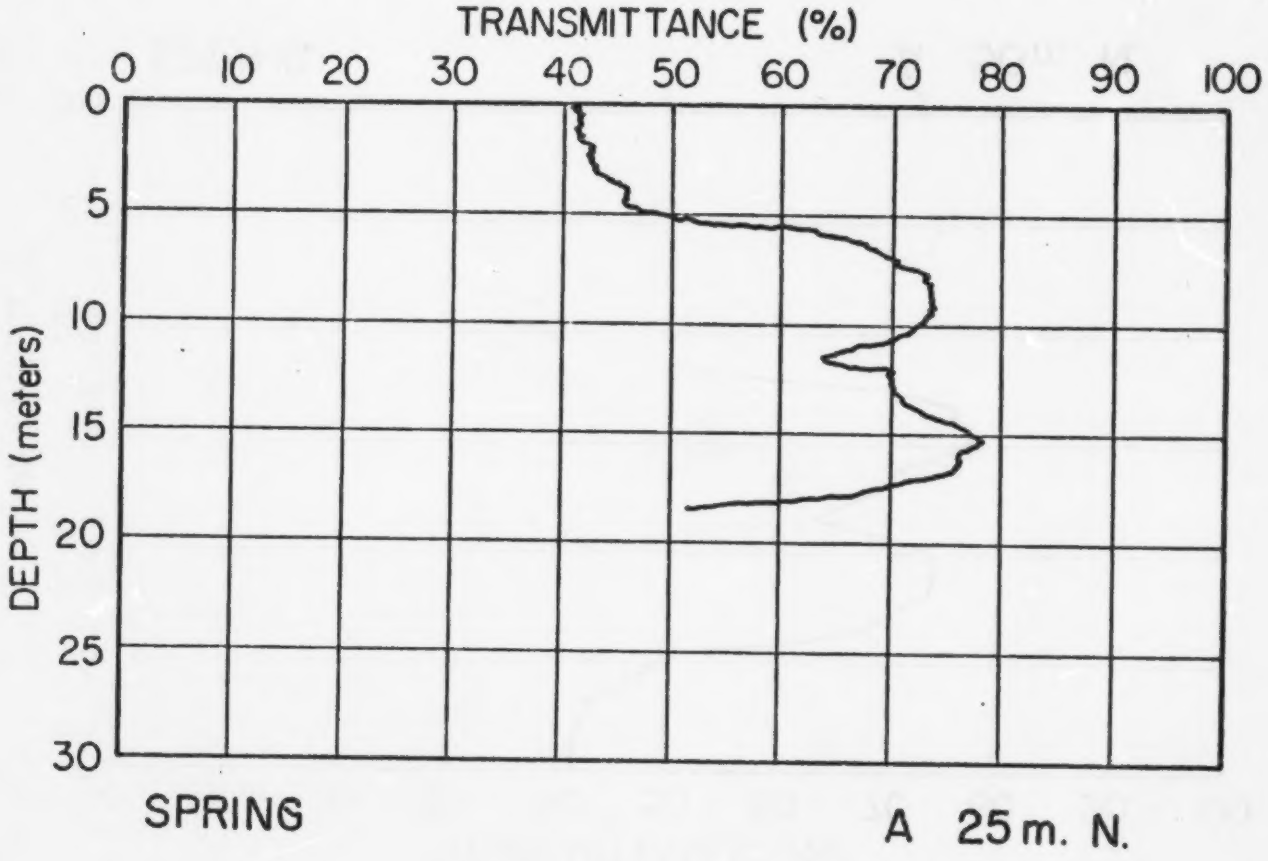
90
100
DEPTH (meters)
0
5
10
15
20
25
30
WINTER
W.J. 25 m. W.



F.S. 25m. W.

WINTER


TRANSMITTANCE (%)
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30
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80
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100
DEPTH (meters)
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5
10
15
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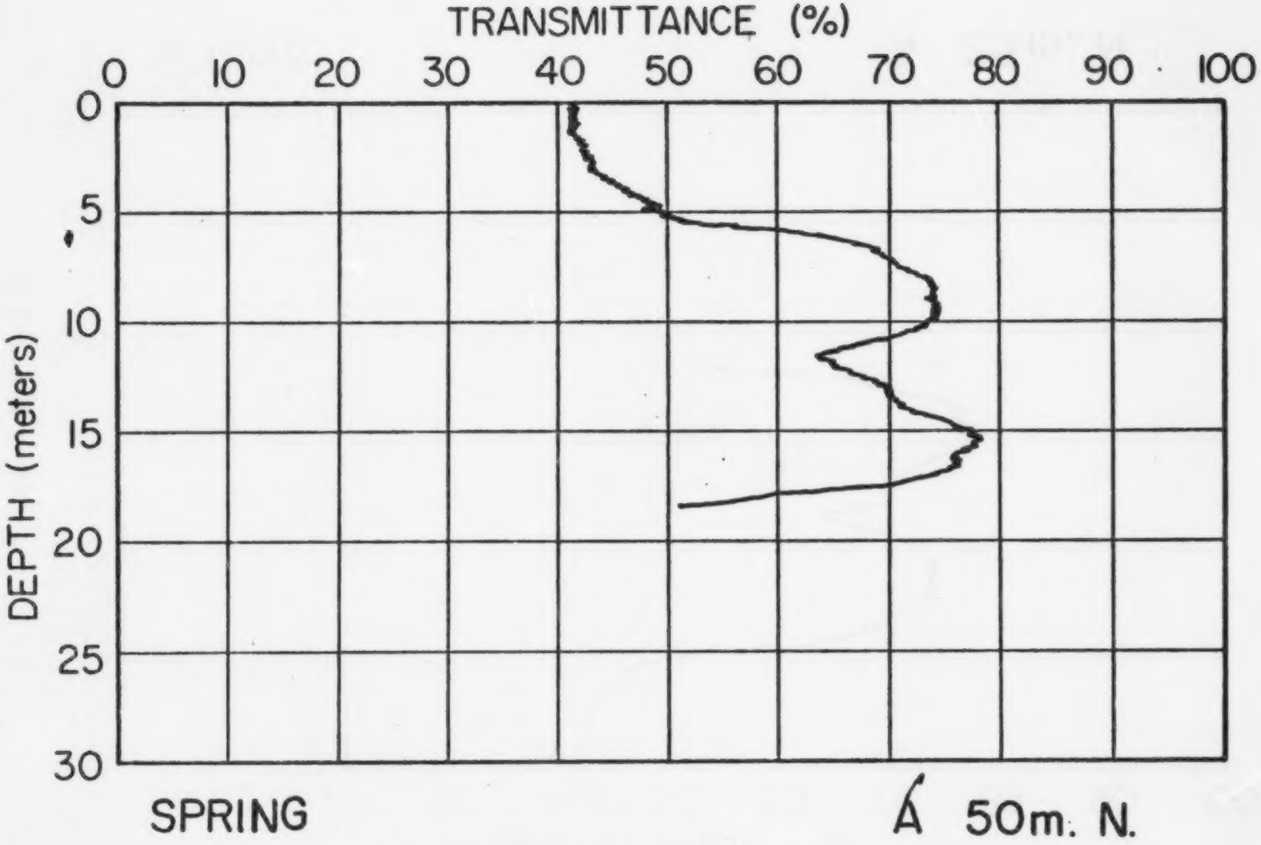
25
30
SPRING
A 25 m. N.


TRANSMITTANCE (%)
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20
30
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60
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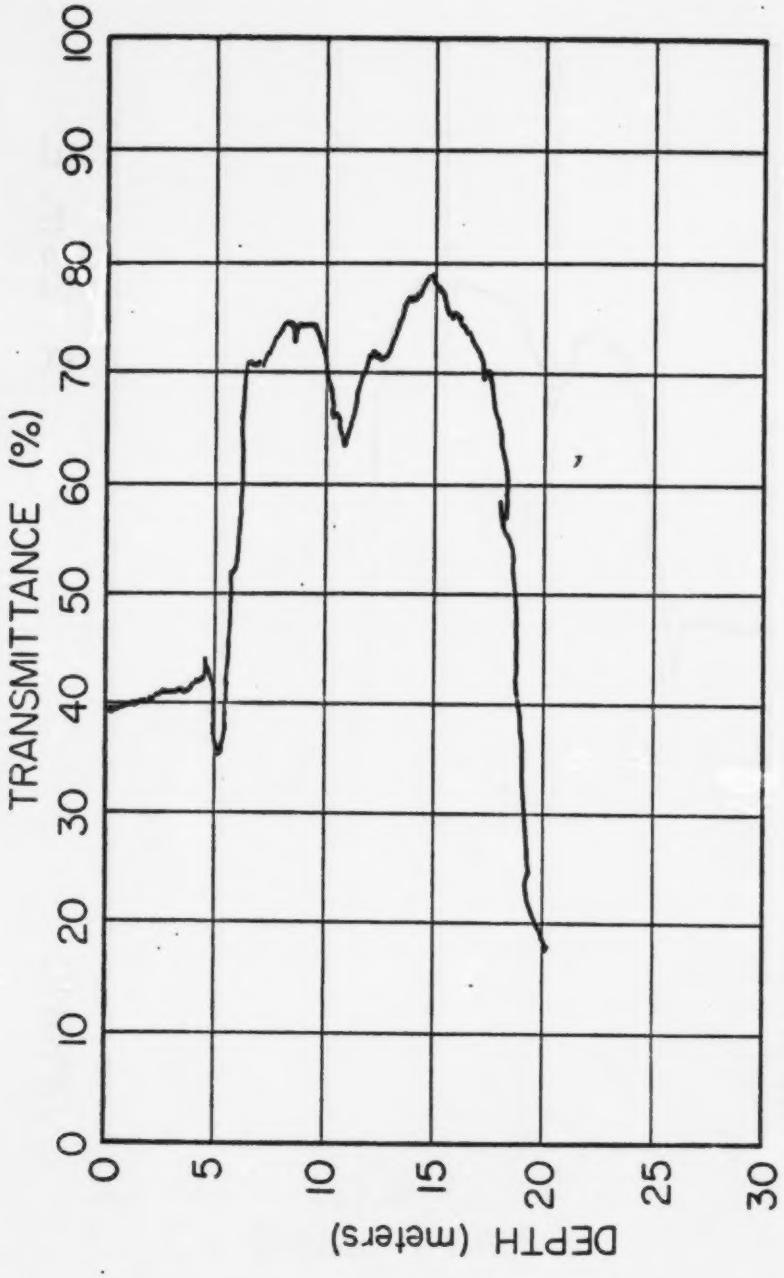
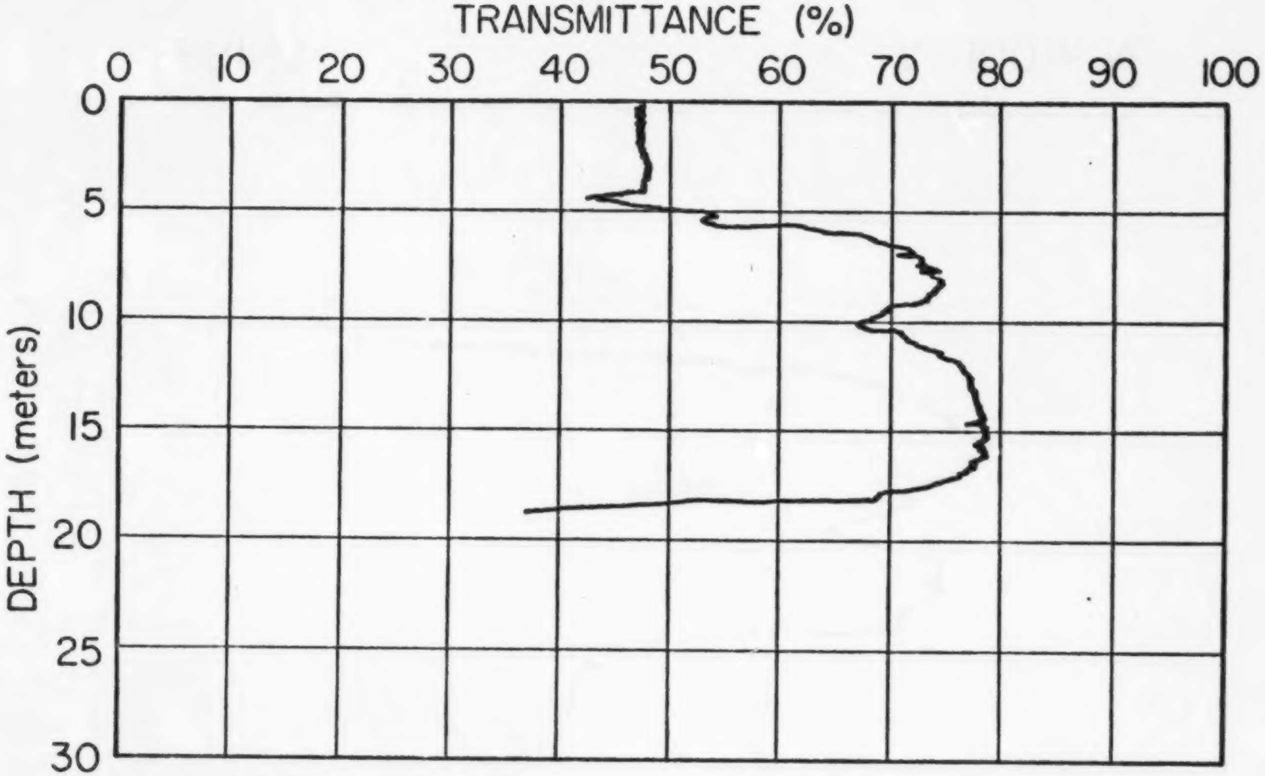
80
90
100
DEPTH (meters)
0
5
10
15
20
25
30
SPRING
Á 50m. N.



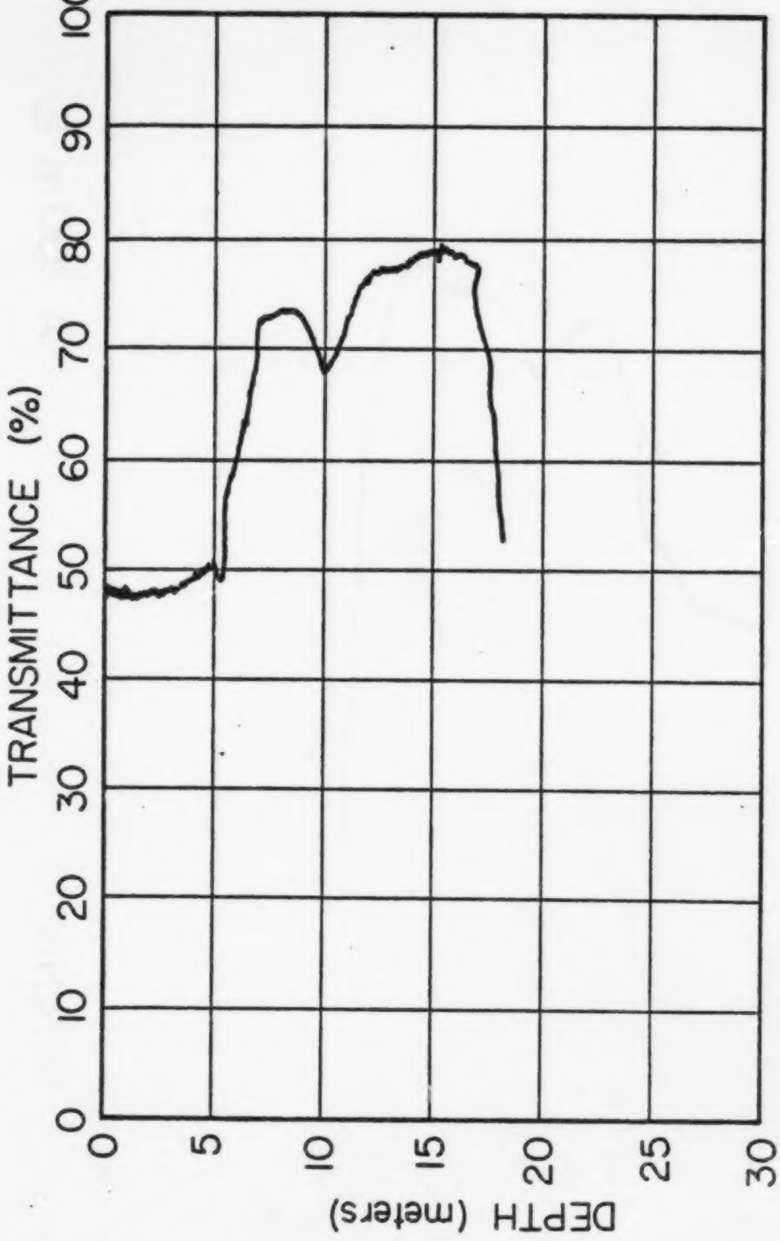
SPRING

A 100 m. N.



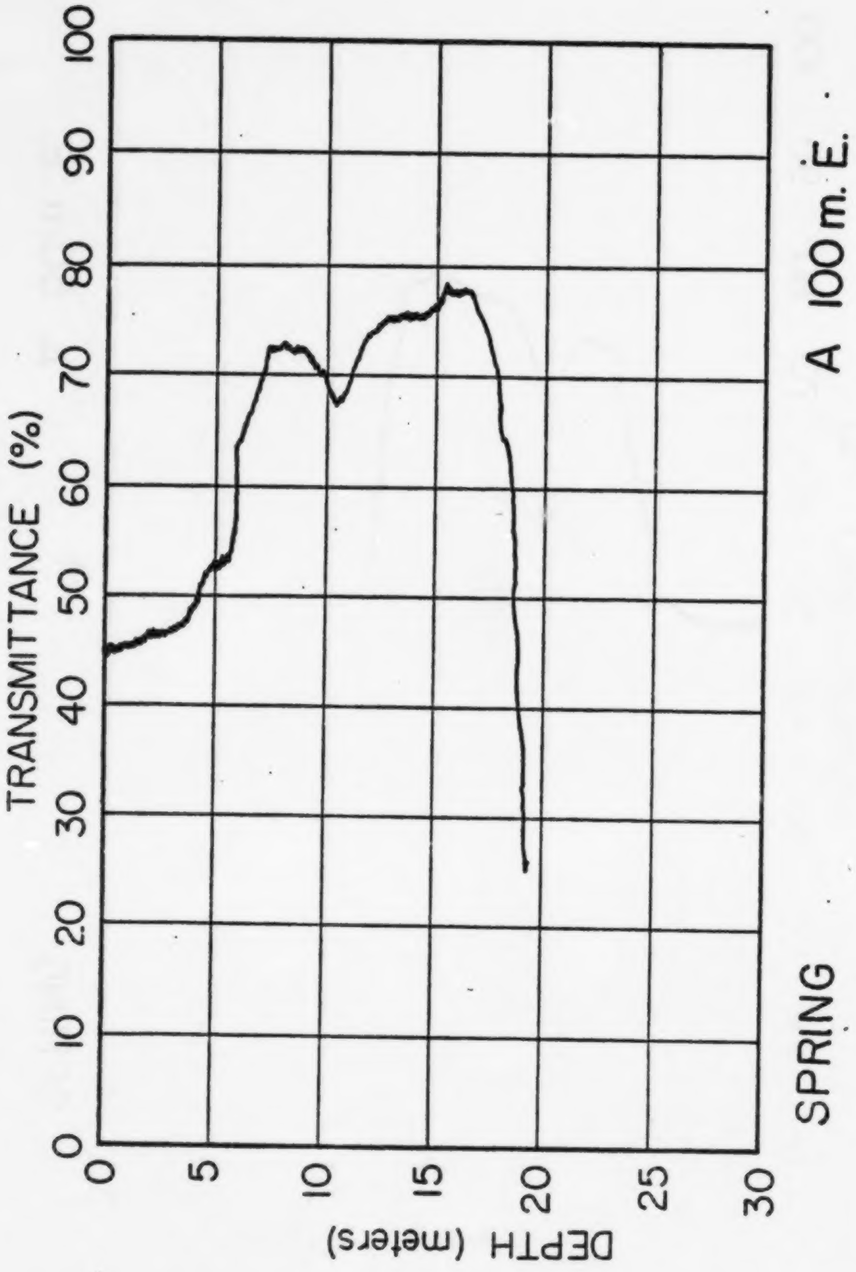
SPRING

A 25 m. E.



A 50m. E.

SPRING


TRANSMITTANCE (%)
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20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
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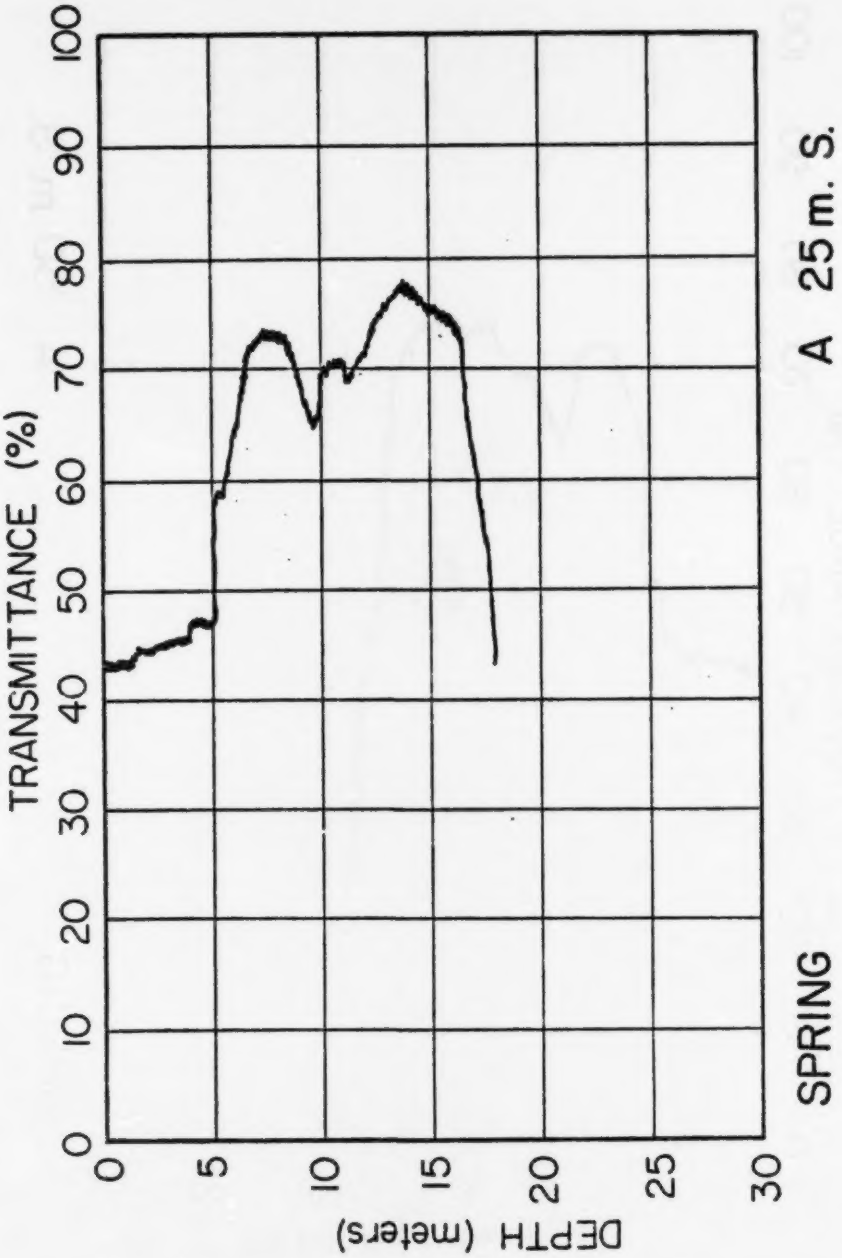
15
20
25
30
A 100 m. E.
SPRING


TRANSMITTANCE (%)
DEPTH (meters)
0
10
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40
50
60
70
80
90
100
0
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15
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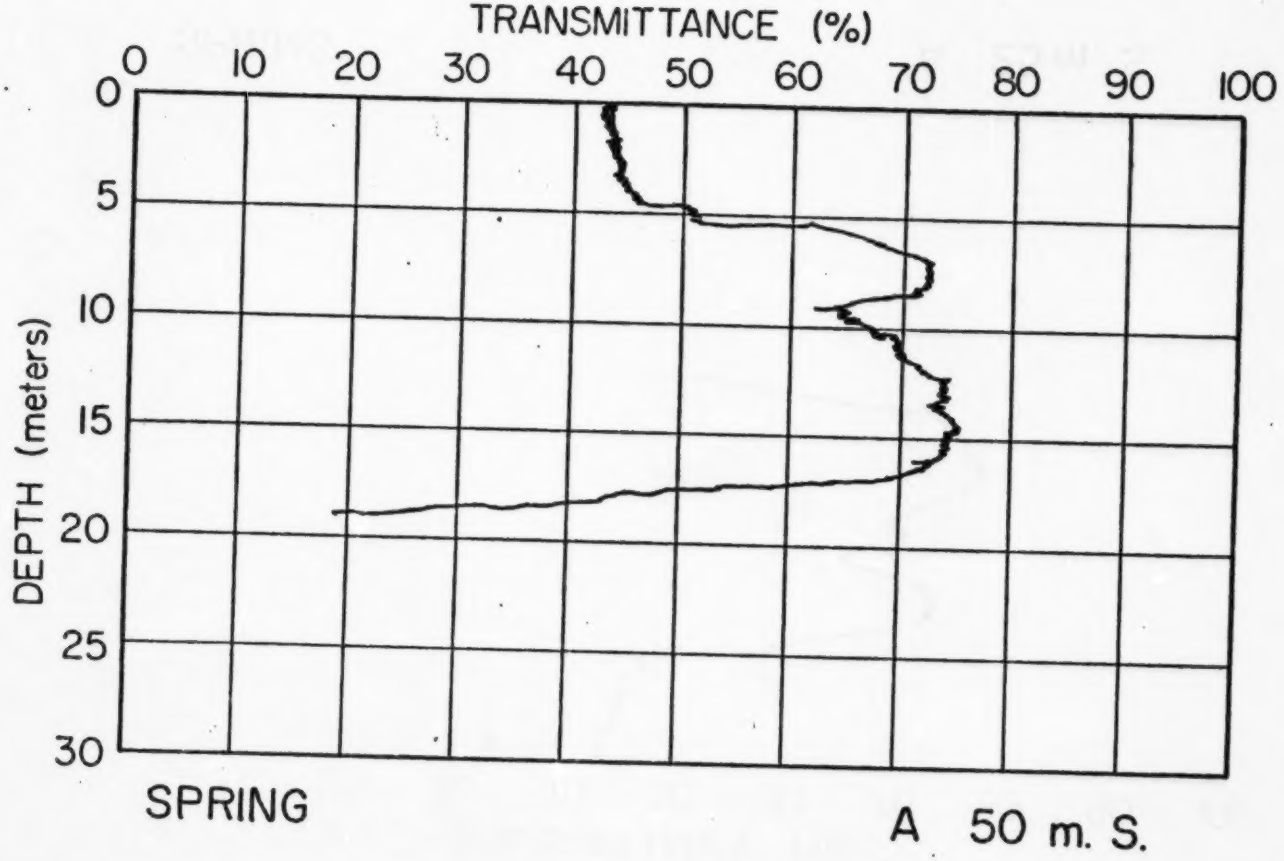
25
30
SPRING
A 25 m. S.


TRANSMITTANCE (%)
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10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
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5
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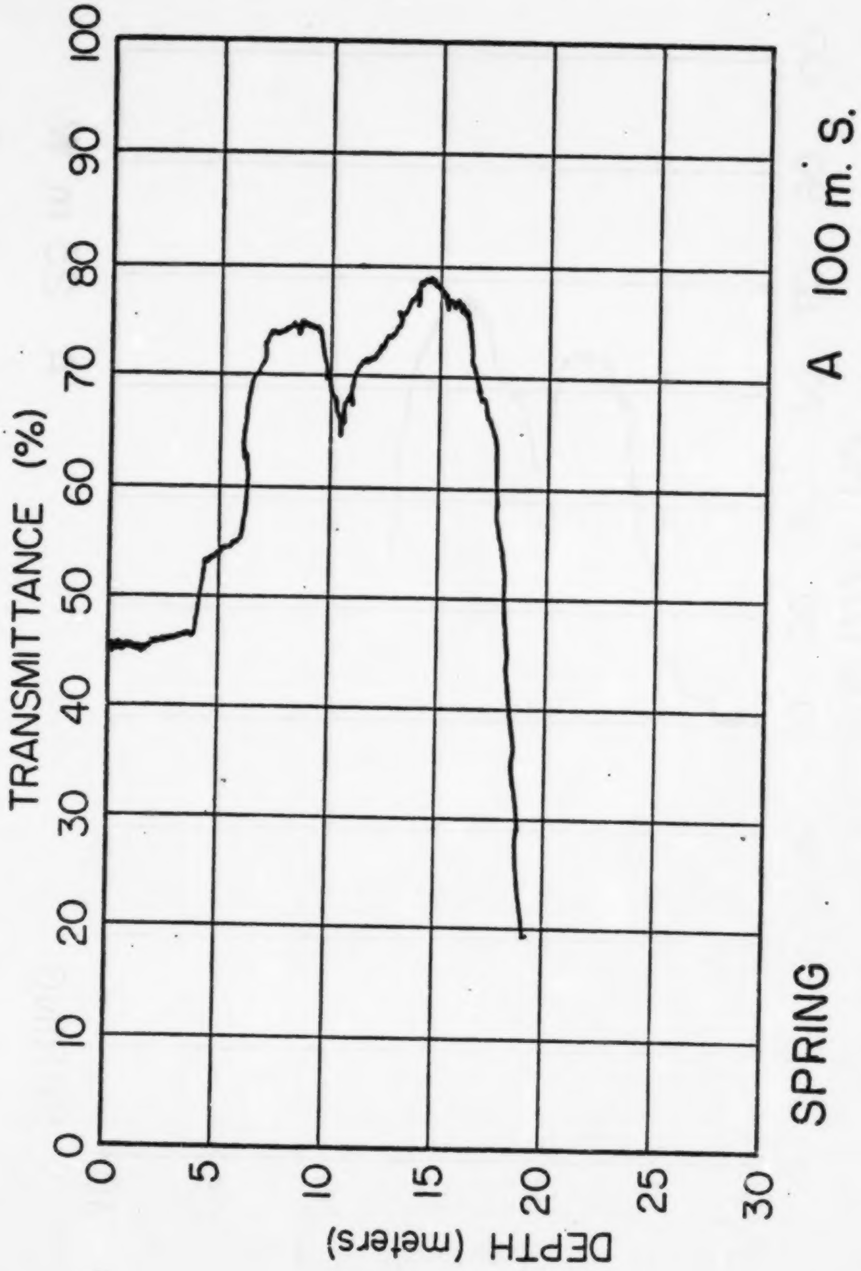
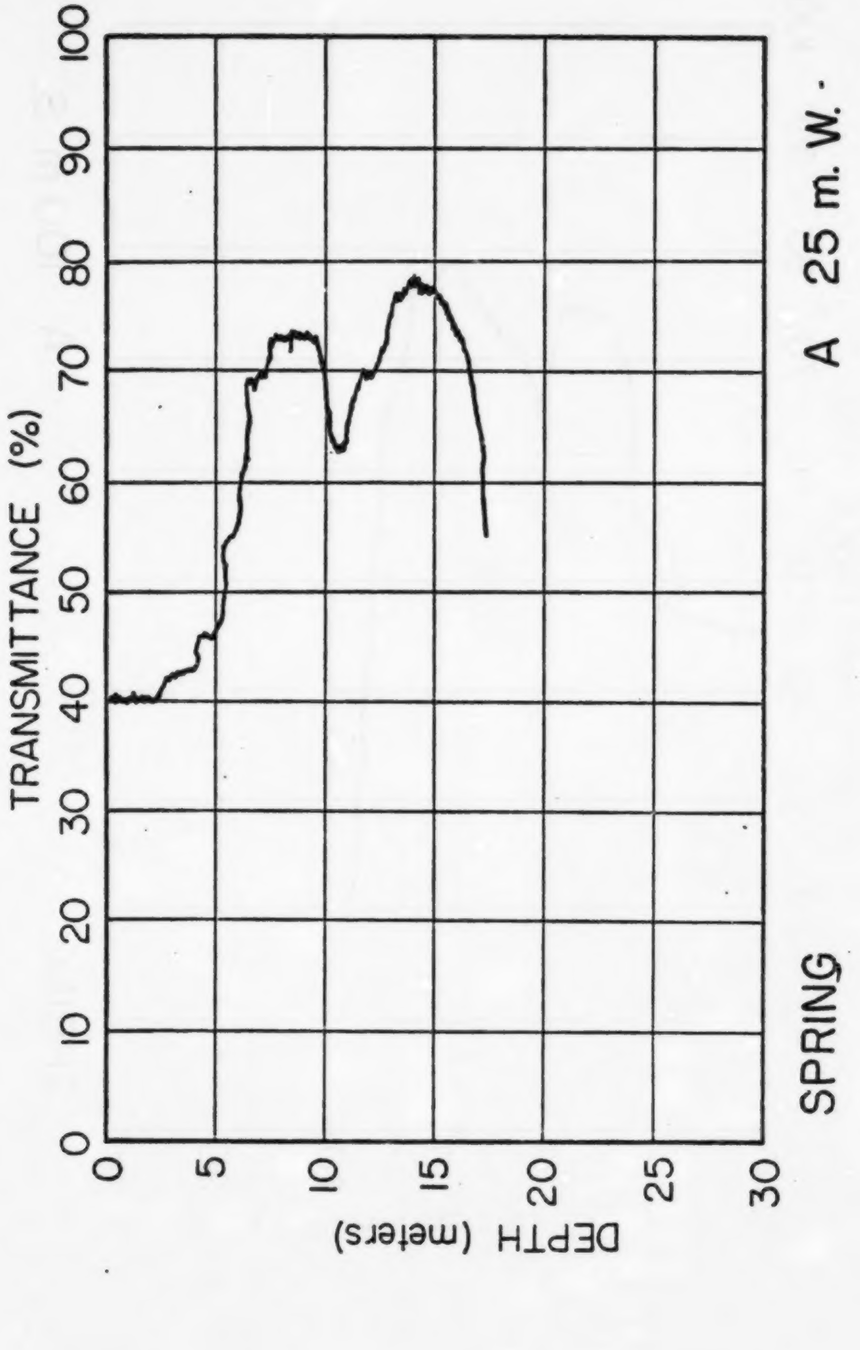
15
20
25
30
SPRING
A 50 m. S.



SPRING

A 100 m. S.


TRANSMITTANCE (%)
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80
90
100
DEPTH (meters)
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5
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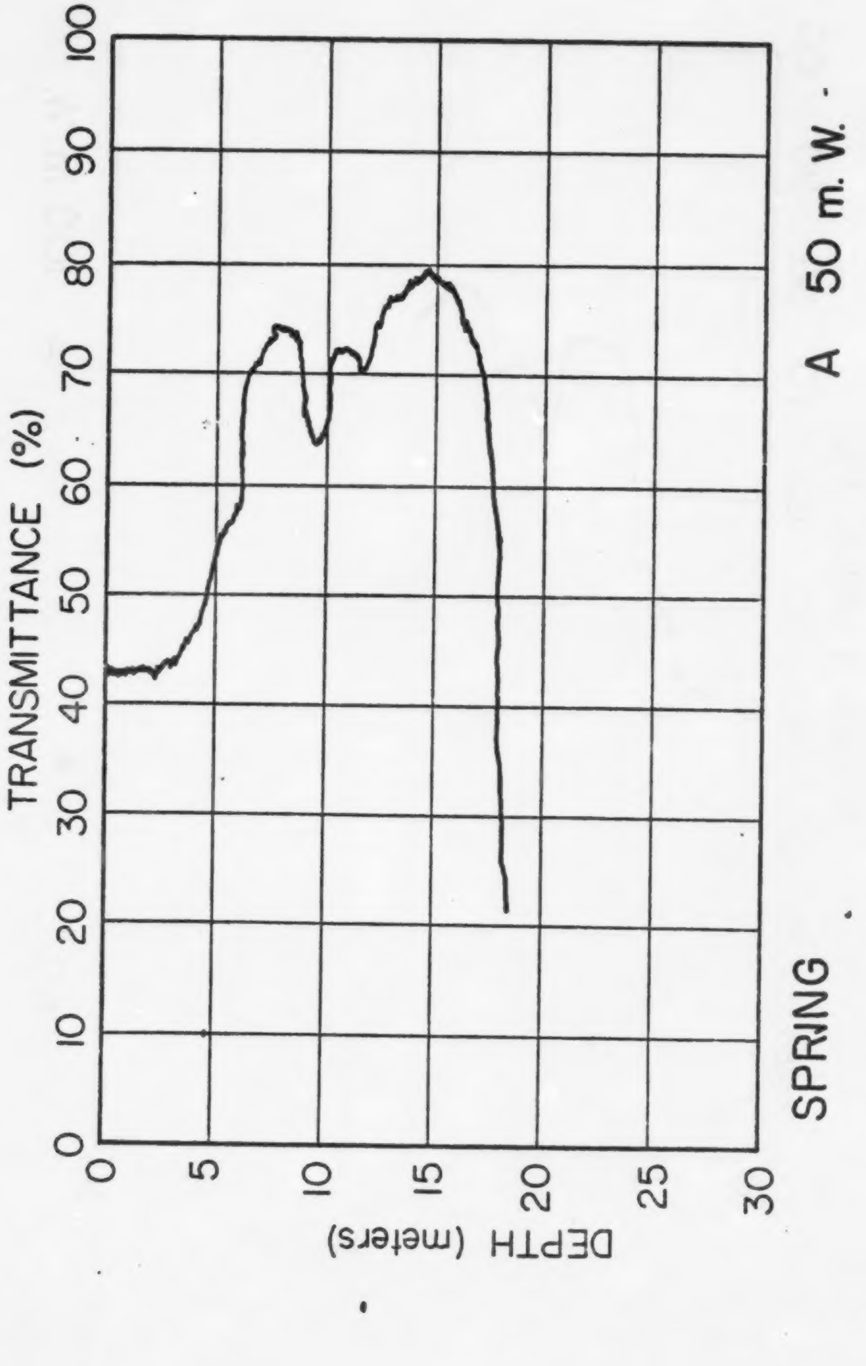
25
30
A 25 m. W.
SPRING


TRANSMITTANCE (%)
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30
40
50
60
70
80
90
100
DEPTH (meters)
0
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25
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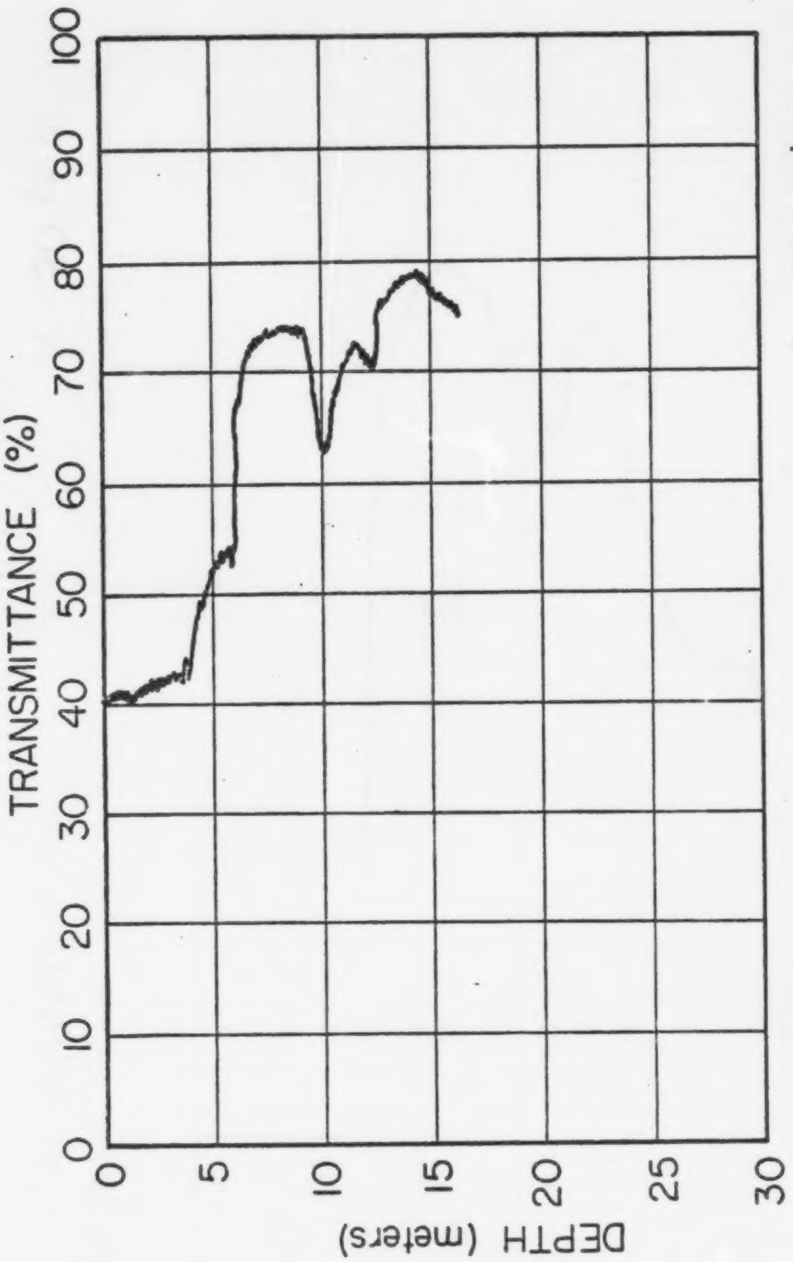
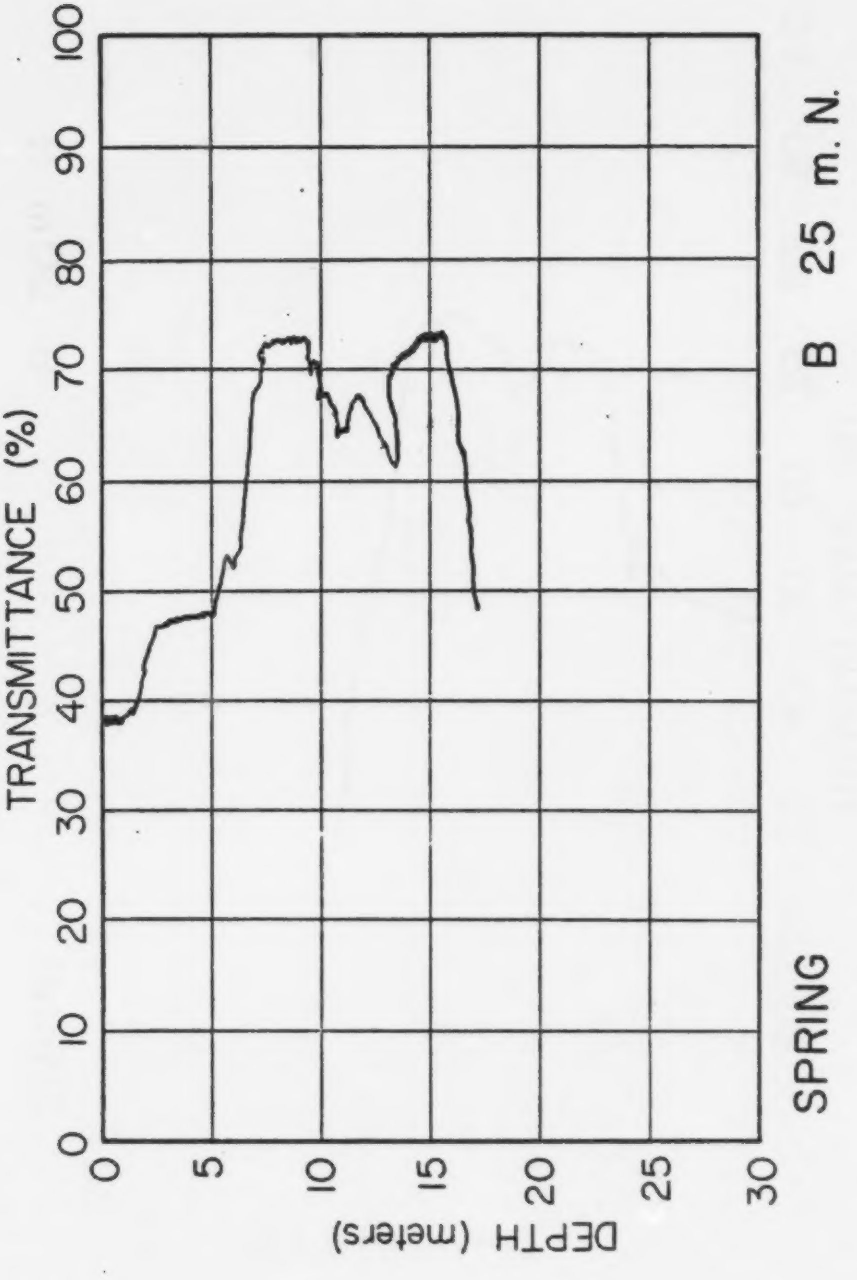
SPRING
A 50 m. W.



A 100 m. W.

SPRING


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
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15
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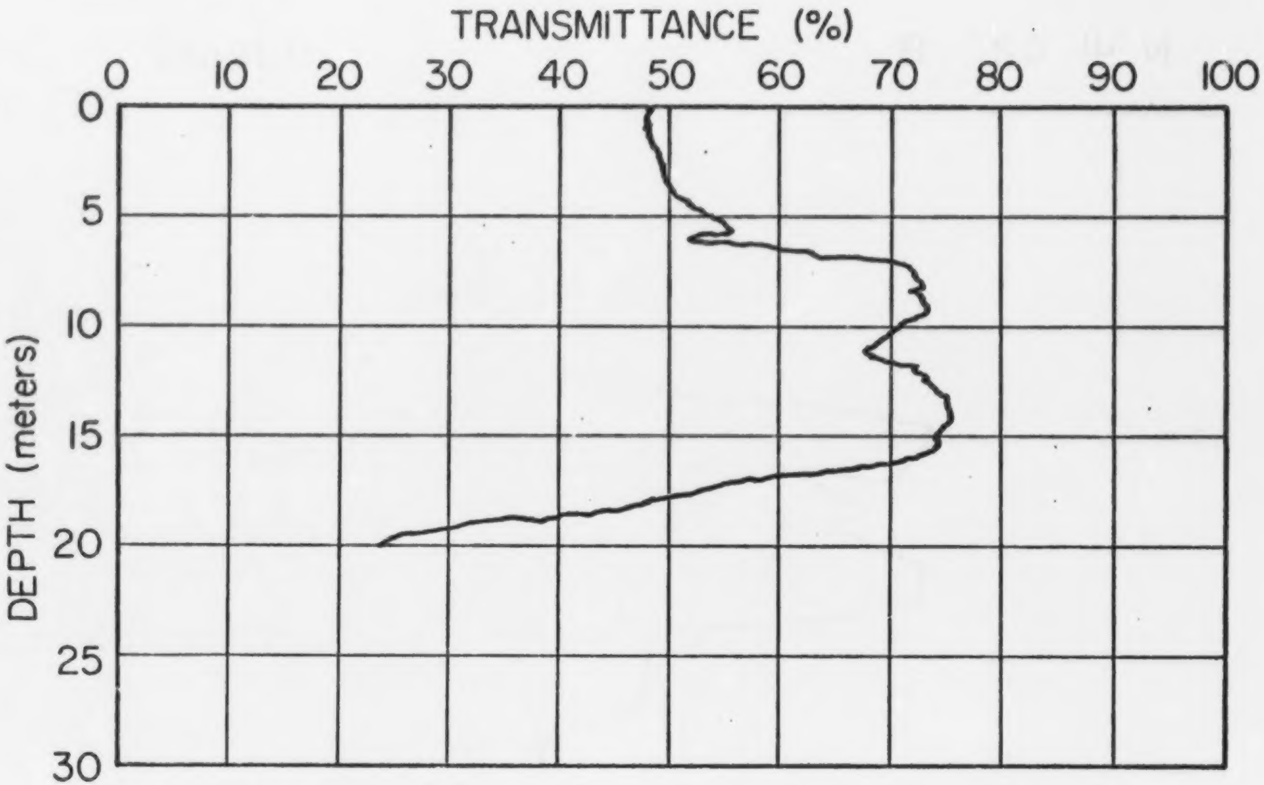
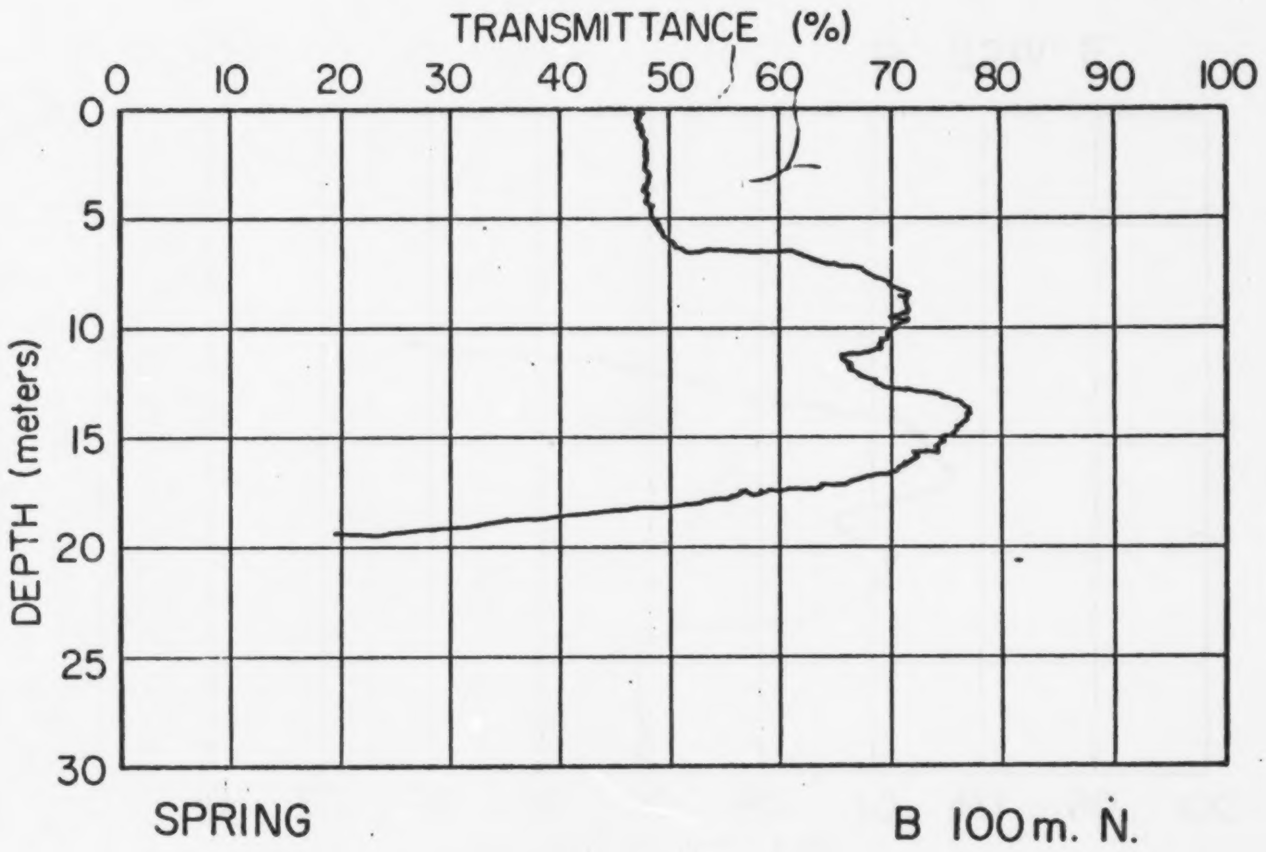
25
30
SPRING
B 25 m. N.



SPRING

B 50m. N.


TRANSMITTANCE (%)
0
10
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30
40
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60
70
80
90
100
DEPTH (meters)
0
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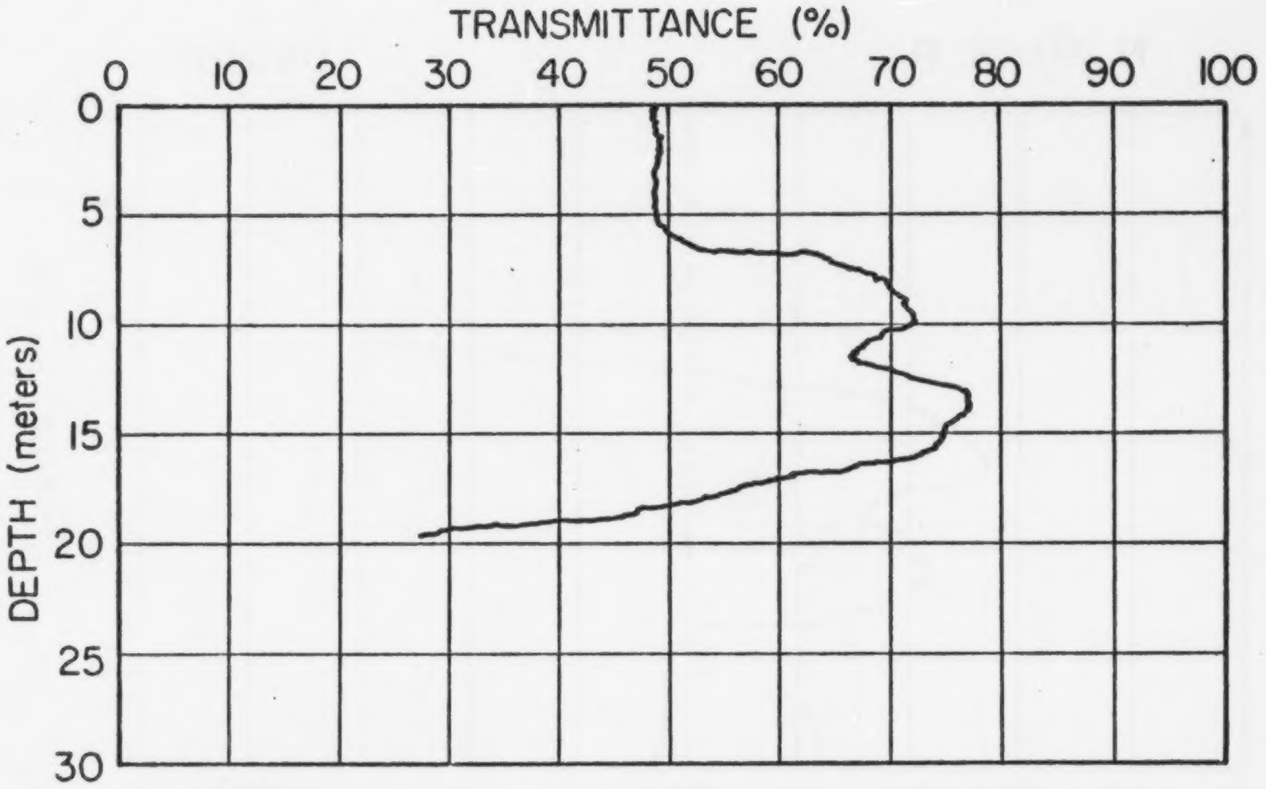
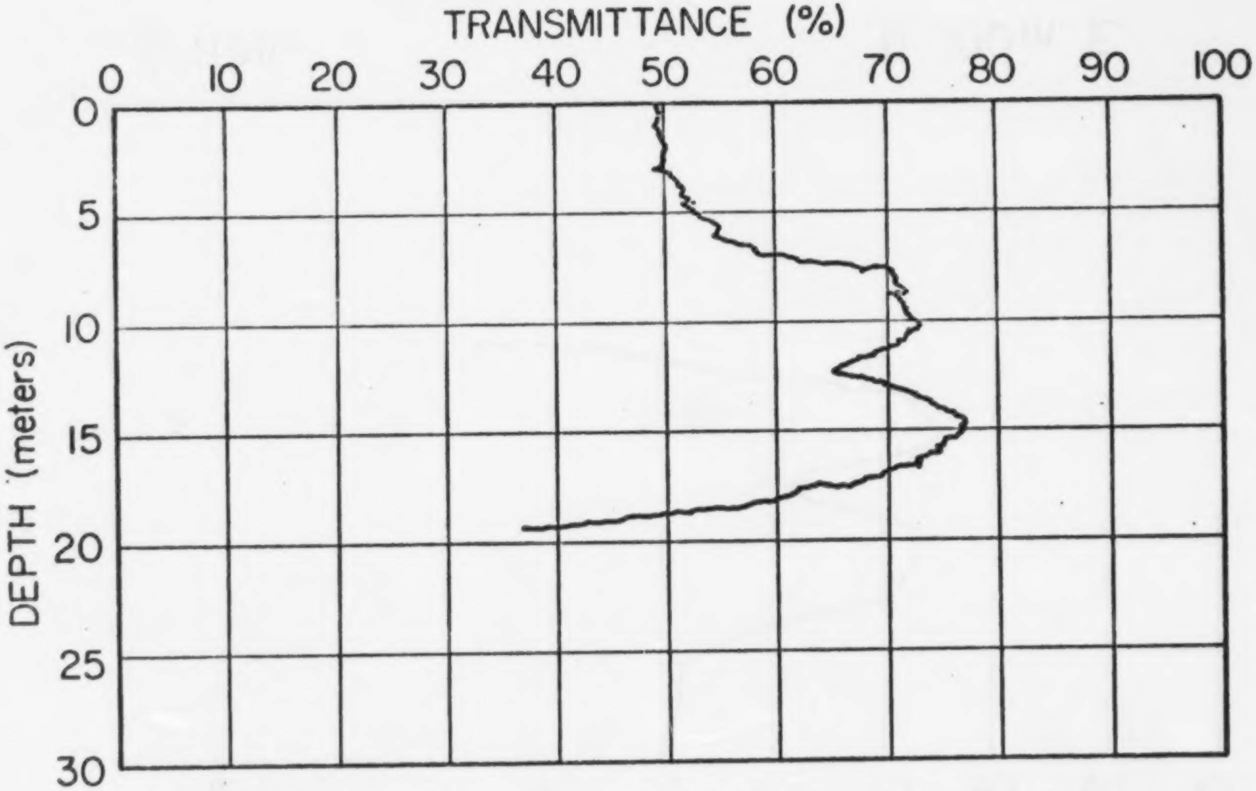
SPRING
B 100m. N.



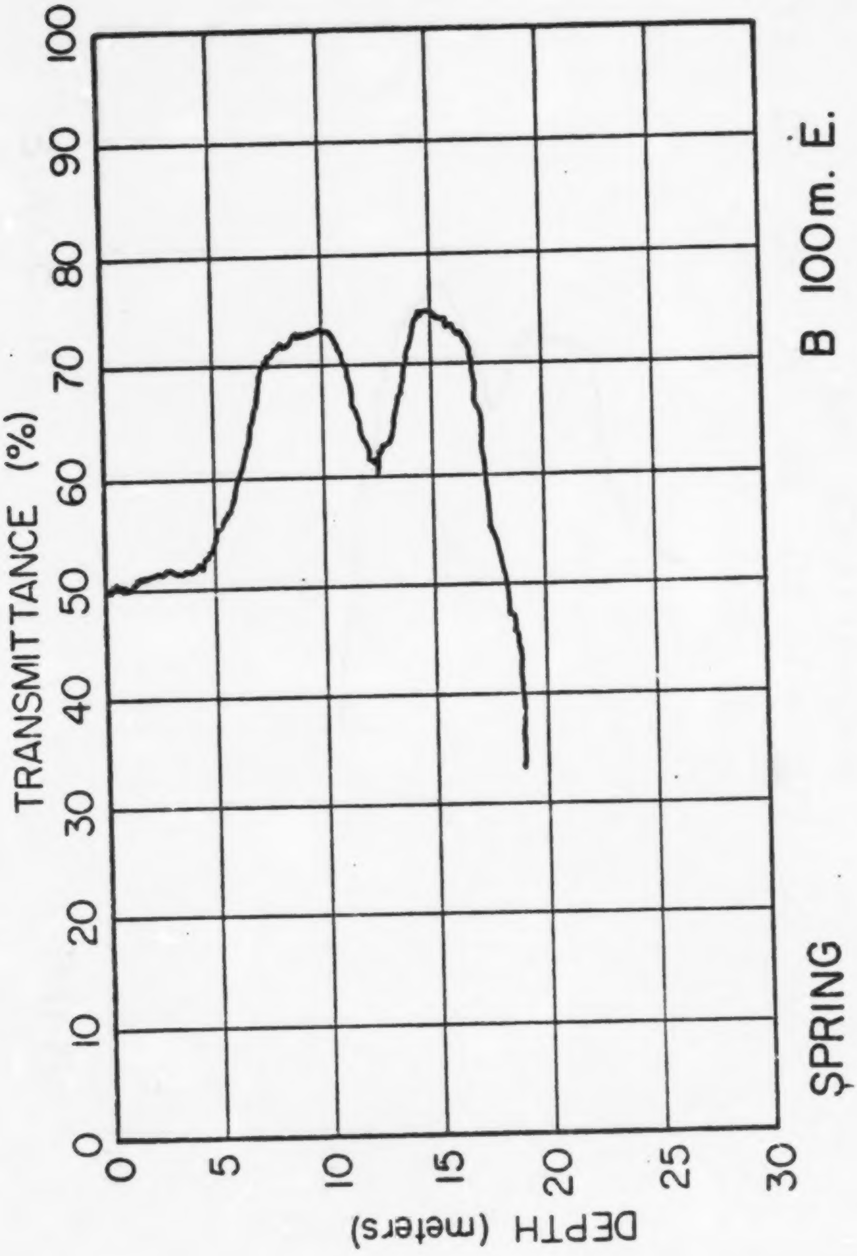
SPRING

B 25m. E.



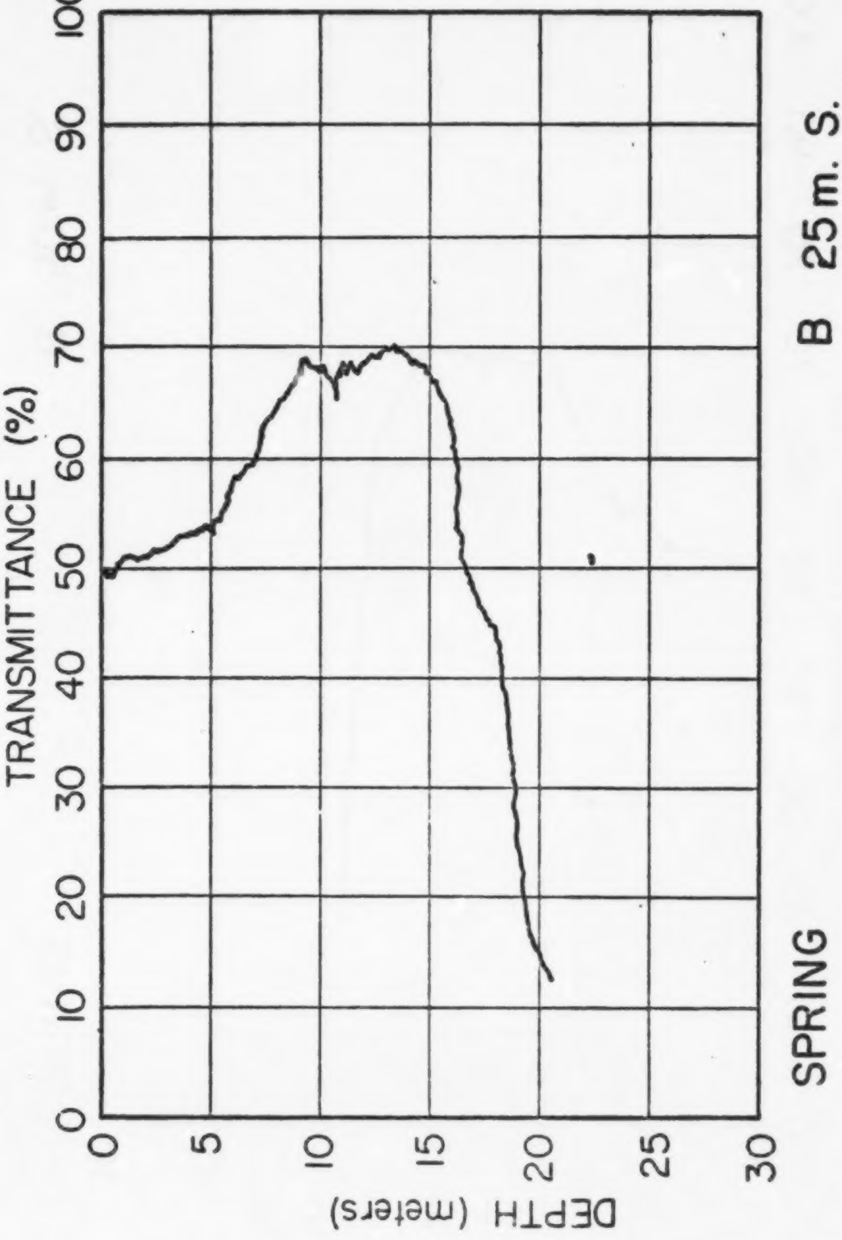
SPRING

B 50m. E.



B 100m. E.

SPRING


TRANSMITTANCE (%)
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40
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80
90
100
DEPTH (meters)
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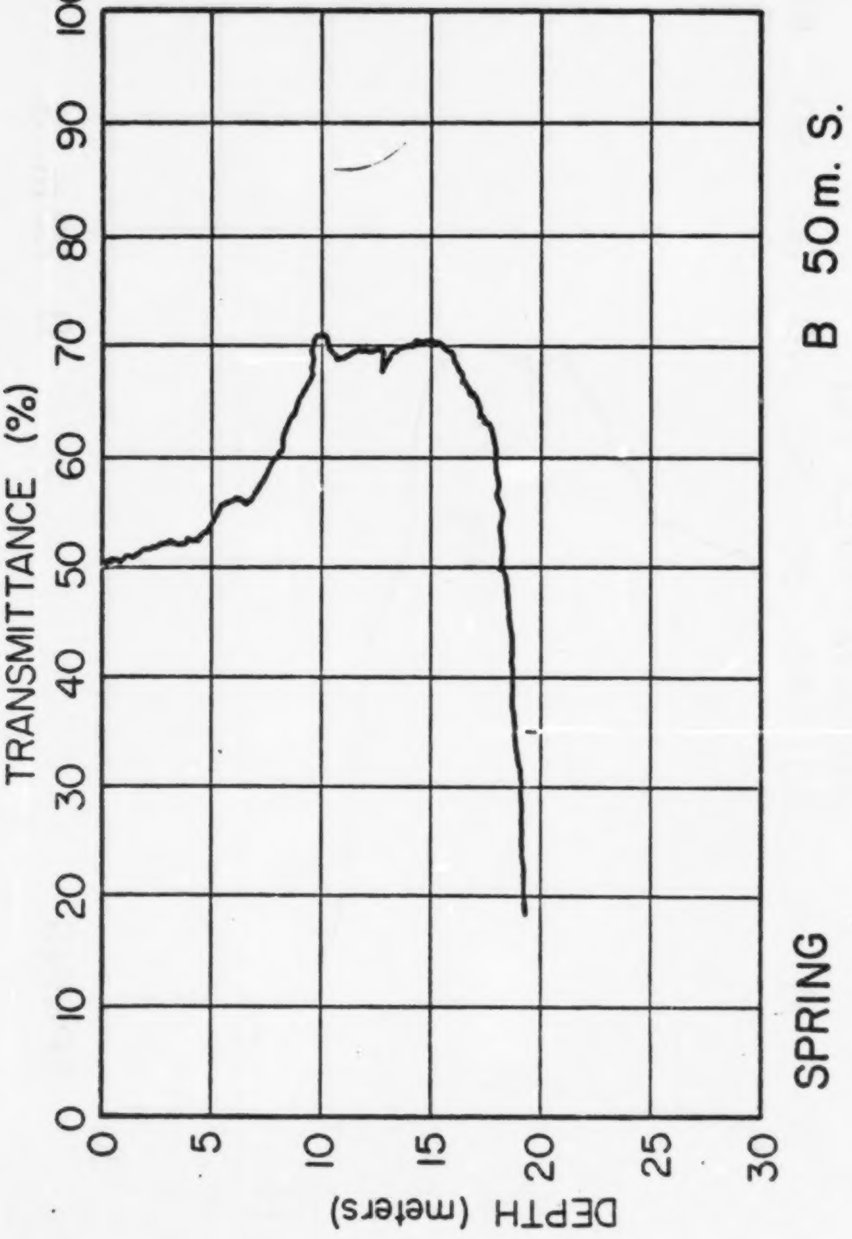
25
30
B 25 m. S.
SPRING


TRANSMITTANCE (%)
0
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30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
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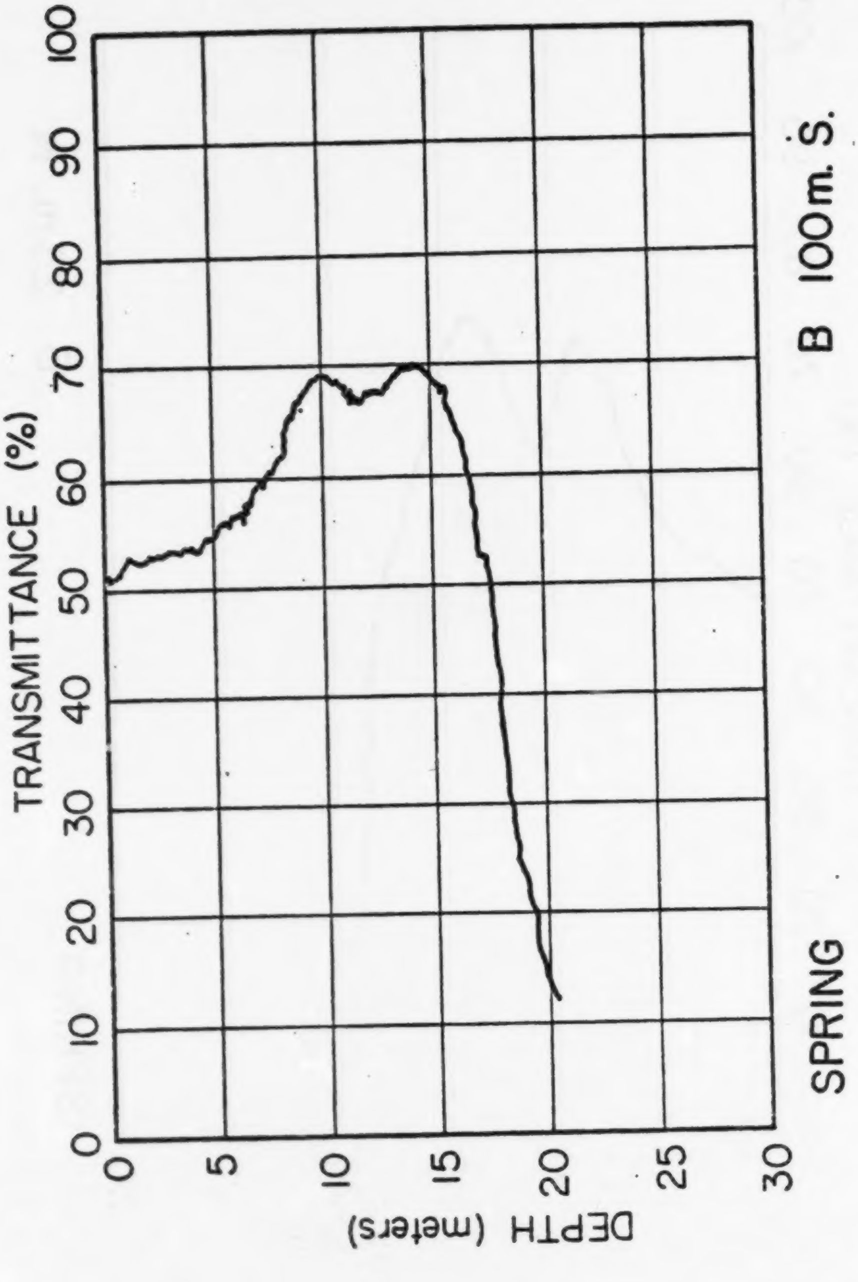
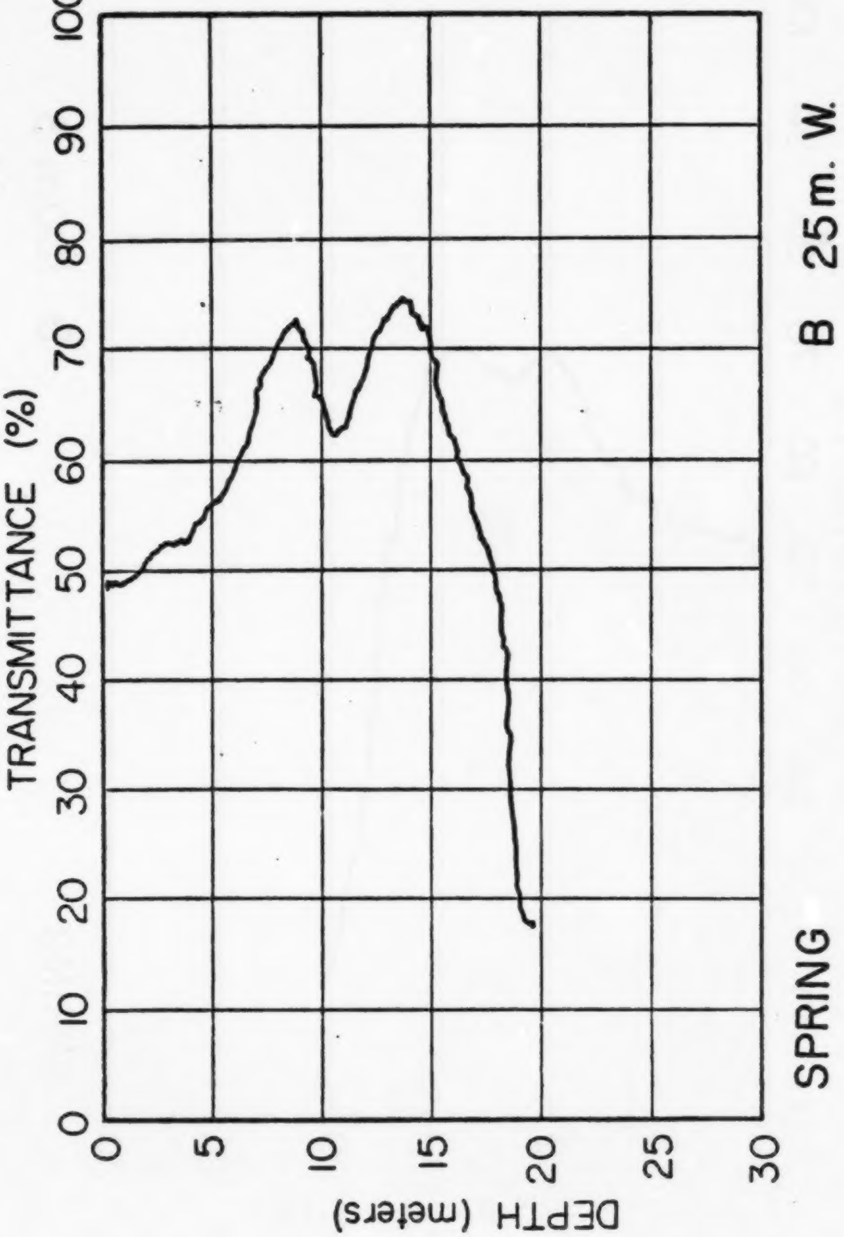
15
20
25
30
B 50m. S.
SPRING


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
10
15
20
25
30
B 100m. S.
SPRING


TRANSMITTANCE (%)
0
10
20
30
40
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60
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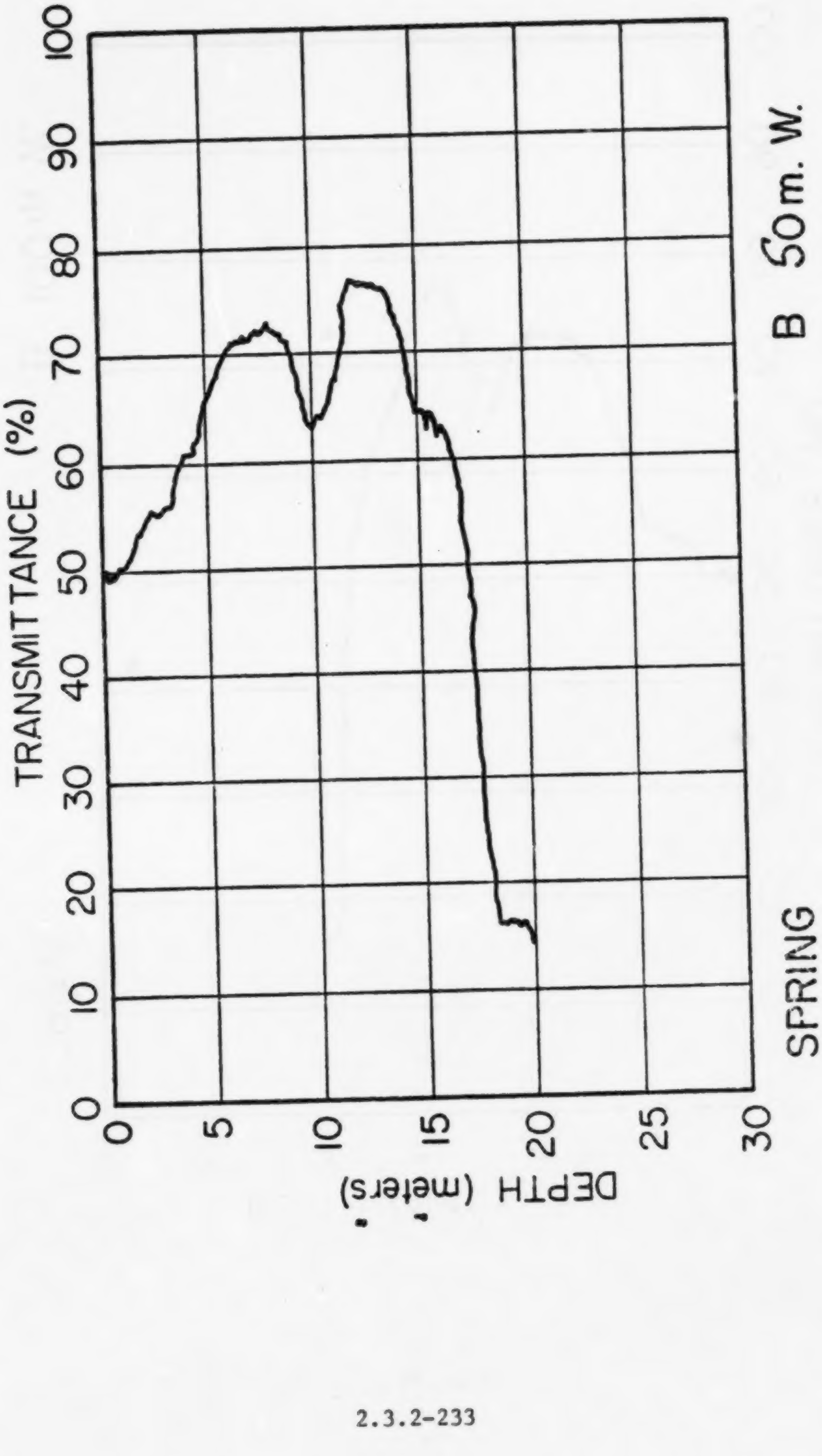
80
90
100
DEPTH (meters)
0
5
10
15
20
25
30
SPRING
B 25m. W.


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
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15
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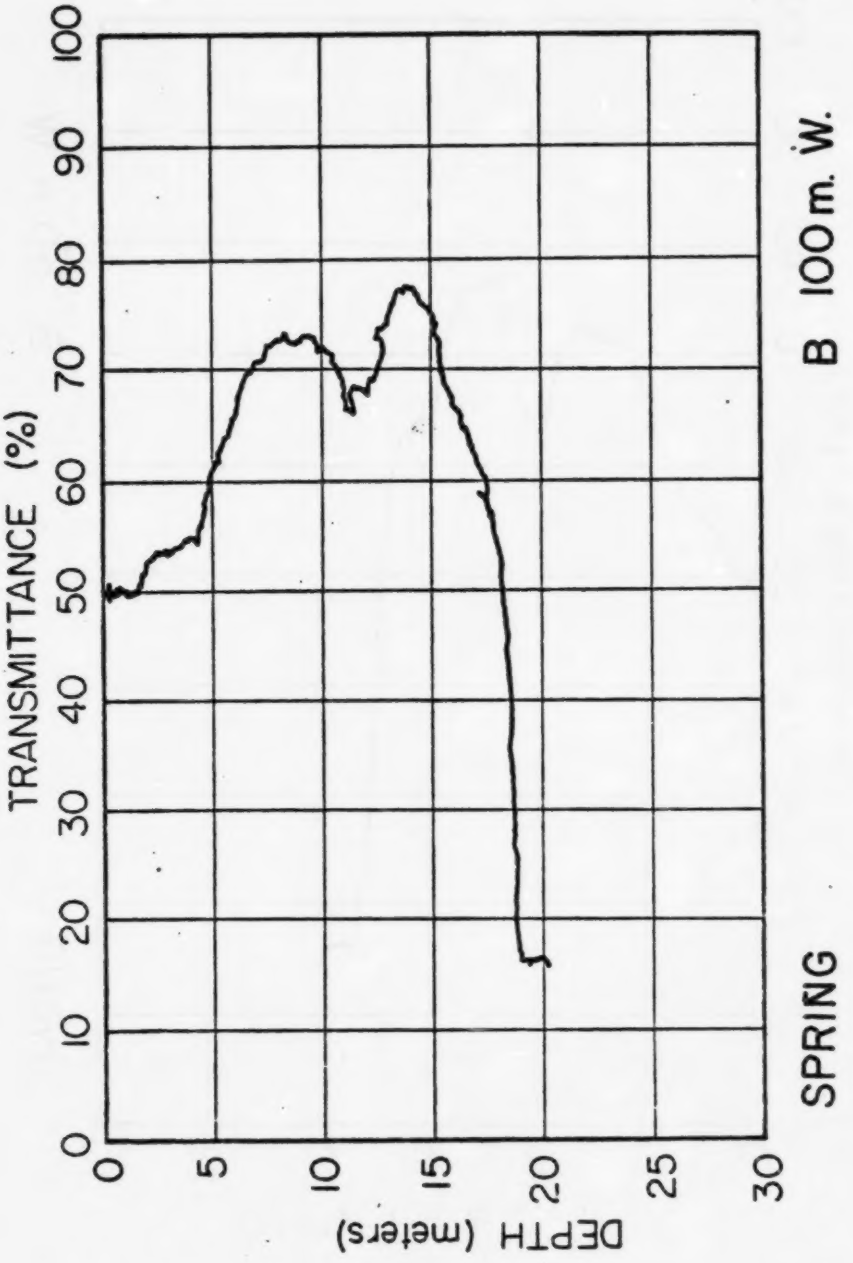
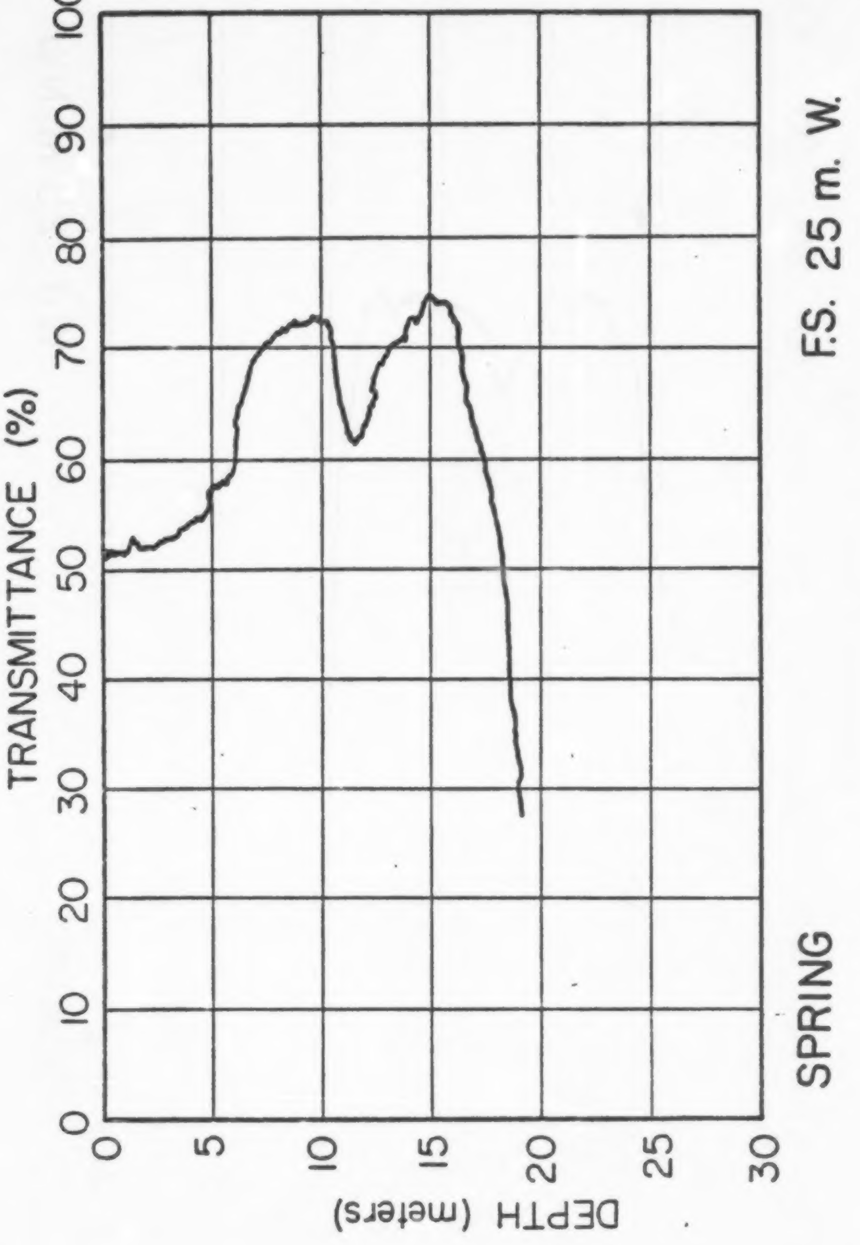
25
30
SPRING
B 50m. W.


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
10
15
20
25
30
B 100 m. W.
SPRING


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
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100
DEPTH (meters)
0
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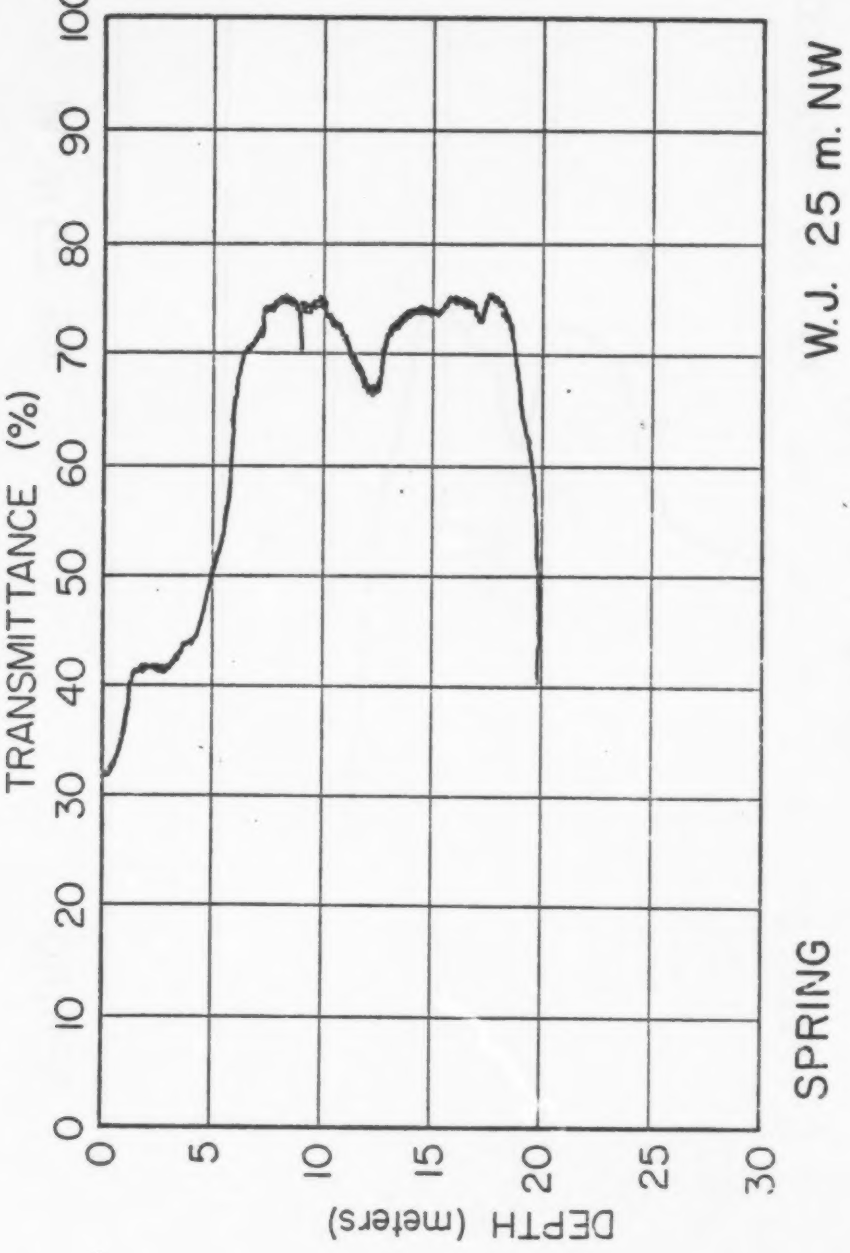
10
15
20
25
30
SPRING
F.S. 25 m. W.


TRANSMITTANCE (%)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (meters)
0
5
10
15
20
25
30
SPRING
W.J. 25 m. NW

6.2. Seasonal Suspended Particulate, Organic Carbon, Chlorophyll, ATP, Calcium Carbonate, Nutrient, and Stable Carbon Isotope Distributions

WATER COLUMN / PLATFORM A / SUMMER SAMPLING

STATION	DISTANCE		TSM (µg/L)	DOC (mgC/L)	POC (µgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	710	1.38	69	-22.5
		BT	2460	1.33	140	-21.6
	50 m	SFC	285	1.18	64	-
		BT	1083	1.16	100	-
	100 m	SFC	543	1.27	76	-
		BT	1680	1.24	93	-
South	25 m	SFC	2093	1.21	62	-22.9
		BT	1531	1.27	78	-21.7
	50 m	SFC	350	1.11	52	-
		BT	3381	1.22	66	-
	100 m	SFC	318	1.14	56	-
		BT	424	1.21	75	-
East	25 m	SFC	205	1.70	79	-22.1
		BT	1447	1.41	97	-24.4
	50 m	SFC	316	1.36	77	-
		BT	224	1.29	89	-
	100 m	SFC	210	1.46	73	-
		BT	380	1.23	84	-
West	25 m	SFC	167	1.24	61	-22.4
		BT	429	1.07	59	-22.6
	50 m	SFC	194	1.93	63	-
		BT	480	1.59	69	-
	100 m	SFC	218	1.13	55	-
		BT	482	0.99	76	-
Well Jacket		SFC	342	1.24	64	-
		BT	2460	1.04	103	-

WATER COLUMN / PLATFORM A / SUMMER SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	0.122	0.009	138	<10
		BT	0.640	0.099	676	<10
	50 m	SFC	0.098	0.038	190	<10
		BT	0.154	0.053	384	<10
	100 m	SFC	0.086	0.032	138	<10
		BT	0.113	0.040	131	<10
South	25 m	SFC	0.066	0.022	212	<10
		BT	0.105	0.043	272	<10
	50 m	SFC	0.061	0.023	139	<10
		BT	0.189	0.017	622	<10
	100 m	SFC	0.049	0.033	427	<10
		BT	0.152	0.046	955	<10
East	25 m	SFC	0.042	0.018	387	<10
		BT	0.044	0.018	231	<10
	50 m	SFC	0.054	0.016	386	<10
		BT	0.105	0.047	698	<10
	100 m	SFC	0.073	0.015	534	<10
		BT	0.054	0.028	244	<10
West	25 m	SFC	0.049	0.025	726	<10
		BT	0.089	0.007	362	<10
	50 m	SFC	0.064	0.012	151	<10
		BT	0.154	0.046	601	<10
	100 m	SFC	0.056	0.016	500	<10
		BT	0.161	0.033	630	<10
Well Jacket		SFC	0.073	0.029	604	<10
		BT	0.580	0.159	615	<10

WATER COLUMN / PLATFORM A / SUMMER SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	2.57	2.50	0.33	0.42	0.16
		BT	4.43	4.43	0.40	0.29	0.19
	50 m	SFC	2.57	2.50	0.37	0.33	0.16
		BT	3.57	3.55	0.30	0.26	0.16
	100 m	SFC	2.43	2.50	0.33	0.29	0.16
		BT	2.57	2.58	0.43	0.29	0.16
South	25 m	SFC	2.57	2.58	0.30	0.26	0.16
		BT	3.43	3.35	0.27	0.26	0.13
	50 m	SFC	2.57	2.66	0.33	0.29	0.16
		BT	3.71	3.71	0.33	0.33	0.16
	100 m	SFC	2.57	2.58	0.30	0.29	0.16
		BT	3.14	3.14	0.33	0.33	0.16
East	25 m	SFC	2.43	2.50	0.27	0.33	0.19
		BT	2.71	2.66	0.30	0.29	0.16
	50 m	SFC	2.43	2.42	0.27	0.29	0.16
		BT	3.29	3.15	0.27	0.29	0.16
	100 m	SFC	2.43	2.42	0.27	0.26	0.16
		BT	2.86	2.82	0.30	0.42	0.19
West	25 m	SFC	2.57	2.58	0.33	0.36	0.16
		BT	2.57	2.58	0.27	0.33	0.16
	50 m	SFC	2.57	2.66	0.37	0.36	0.16
		BT	3.29	3.30	0.33	0.36	0.16
	100 m	SFC	2.57	2.58	0.30	0.36	0.16
		BT	3.29	3.30	0.33	0.33	0.16
Well Jacket		SFC	2.57	2.68	0.27	0.23	0.13
		BT	3.57	3.63	0.27	0.23	0.13

WATER COLUMN / PLATFORM B / SUMMER SAMPLING

STATION	DISTANCE		TSM (μg/L)	DOC (mgC/L)	POC (μgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	587	1.30	74	-24.6
		BT	1650	1.25	67	-23.2
	50 m	SFC	371	1.69	63	-
		BT	800	1.28	66	-
	100 m	SFC	470	1.31	63	-
		BT	262	1.33	67	-
South	25 m	SFC	195	1.36	53	-22.3
		BT	337	1.30	83	-22.7
	50 m	SFC	266	1.35	99	-
		BT	337	1.41	83	-
	100 m	SFC	233	1.34	56	-
		BT	469	1.35	88	-
East	25 m	SFC	196	1.47	65	-22.7
		BT	339	1.46	75	-23.7
	50 m	SFC	286	1.39	62	-
		BT	315	1.35	76	-
	100 m	SFC	442	1.31	64	-
		BT	555	1.23	71	-
West	25 m	SFC	124	1.35	51	-21.7
		BT	464	1.44	92	-22.6
	50 m	SFC	216	1.39	49	-
		BT	332	1.67	62	-
	100 m	SFC	177	1.38	52	-
		BT	446	1.39	78	-
Flare Stack		SFC	186	1.25	76	-
		BT	590	1.05	72	-

WATER COLUMN / PLATFORM B / SUMMER SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	0.051	0.029	391	<10
		BT	0.086	0.054	390	<10
	50 m	SFC	0.078	0.029	291	<10
		BT	0.137	0.027	362	<10
	100 m	SFC	0.061	0.021	529	<10
		BT	0.066	0.018	453	<10
South	25 m	SFC	0.059	0.028	404	<10
		BT	0.127	0.050	1050	<10
	50 m	SFC	0.066	0.024	344	<10
		BT	0.174	0.028	810	<10
	100 m	SFC	0.083	0.015	444	<10
		BT	0.133	0.067	1312	<10
East	25 m	SFC	0.069	0.014	927	<10
		BT	0.122	0.044	1002	<10
	50 m	SFC	0.076	0.029	790	<10
		BT	0.130	0.039	1107	<10
	100 m	SFC	0.034	0.017	1421	<10
		BT	0.066	0.092	521	<10
West	25 m	SFC	0.056	0.030	405	<10
		BT	0.196	0.051	1454	<10
	50 m	SFC	0.029	0.032	272	<10
		BT	0.105	0.047	491	<10
	100 m	SFC	0.049	0.027	308	<10
		BT	0.145	0.030	977	<10
Flare Stack		SFC	0.049	0.021	266	<10
		BT	0.140	0.056	556	<10

WATER COLUMN / PLATFORM B / SUMMER SAMPLING

STATION	DISTANCE		Total SiO_2 (µM)	Dis. SiO_2 (µM)	Phosphate (µM)	Nitrate (µM)	Nitrite (µM)
North	25 m	SFC	2.43	2.42	0.30	0.23	0.13
		BT	2.14	2.10	0.60	0.26	0.13
	50 m	SFC	2.14	2.10	0.37	0.29	0.13
		BT	2.57	2.58	0.33	0.23	0.13
	100 m	SFC	1.57	1.61	0.67	0.20	0.13
		BT	2.29	2.30	0.43	0.29	0.16
South	25 m	SFC	2.00	2.02	0.27	0.26	0.13
		BT	2.71	2.64	0.27	0.23	0.16
	50 m	SFC	2.00	2.02	0.23	0.23	0.13
		BT	2.00	2.02	0.27	0.23	0.13
	100 m	SFC	2.00	2.10	0.27	0.26	0.13
		BT	3.29	3.31	0.27	0.26	0.13
East	25 m	SFC	2.14	2.10	0.27	0.23	0.16
		BT	2.86	2.82	0.27	0.29	0.16
	50 m	SFC	2.29	2.26	0.27	0.26	0.13
		BT	3.00	3.06	0.33	0.29	0.16
	100 m	SFC	1.29	1.29	0.17	0.16	0.10
		BT	2.57	2.58	0.23	0.26	0.13
West	25 m	SFC	1.86	1.85	0.30	0.23	0.13
		BT	2.14	2.18	0.30	0.26	0.13
	50 m	SFC	2.14	2.18	0.23	0.23	0.13
		BT	2.57	2.58	0.30	0.23	0.13
	100 m	SFC	2.29	2.34	0.23	0.23	0.13
		BT	2.29	2.34	0.27	0.26	0.16
Flare Stack		SFC	1.86	1.85	0.23	0.20	0.16
		BT	3.14	3.14	0.27	0.23	0.16

WATER COLUMN / PLATFORM A / FALL SAMPLING

STATION	DISTANCE		TSM (μg/L)	DOC (mgC/L)	POC (μgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	600	1.36	75	-22.4
		BT	979	1.31	80	-23.4
	50 m	SFC	730	1.29	74	-
		BT	938	1.29	85	-
	100 m	SFC	1002	1.52	64	-
		BT	1026	1.67	70	-
South	25 m	SFC	889	1.07	59	-22.8
		BT	994	1.19	57	-25.6
	50 m	SFC	1022	1.09	62	-
		BT	923	1.00	72	-
	100 m	SFC	958	1.18	65	-
		BT	928	0.94	61	-
East	25 m	SFC	1445	1.19	70	-22.5
		BT	904	1.16	73	-24.0
	50 m	SFC	574	1.13	69	-
		BT	2030	1.14	75	-
	100 m	SFC	497	1.44	74	-
		BT	1523	1.02	95	-
West	25 m	SFC	678	0.93	57	-22.2
		BT	735	0.91	58	-24.1
	50 m	SFC	735	1.07	62	-
		BT	720	1.01	74	-
	100 m	SFC	663	1.30	69	-
		BT	1102	1.10	75	-
Well Jacket		SFC	369	1.09	66	-
		BT	405	1.15	71	-

WATER COLUMN / PLATFORM A / FALL SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	0.112	0.141	163	1.01
		BT	0.168	0.249	335	2.61
	50 m	SFC	0.126	0.109	209	1.24
		BT	0.125	0.167	183	1.97
	100 m	SFC	0.118	0.175	209	1.53
		BT	0.105	0.154	148	0.83
South	25 m	SFC	0.118	0.156	402	1.79
		BT	0.110	0.005	301	0.33
	50 m	SFC	0.093	0.154	269	0.20
		BT	0.098	0.149	566	0.75
	100 m	SFC	0.119	0.181	296	1.25
		BT	0.112	0.141	569	0.98
East	25 m	SFC	0.098	0.132	180	4.79
		BT	0.105	0.160	249	0.35
	50 m	SFC	0.098	0.132	445	1.48
		BT	0.168	0.149	551	0.83
	100 m	SFC	0.088	0.113	181	3.43
		BT	0.175	0.184	426	3.31
West	25 m	SFC	0.119	0.140	568	0.33
		BT	0.119	0.116	189	3.50
	50 m	SFC	0.078	0.143	171	1.08
		BT	0.140	0.113	155	0.08
	100 m	SFC	0.130	0.164	384	1.25
		BT	0.140	0.183	338	8.75
Well Jacket		SFC	0.182	0.171	272	0.75
		BT	0.119	0.128	401	0.33

WATER COLUMN / PLATFORM A / FALL SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	5.37	5.20	0.60	0.41	0.21
		BT	5.20	5.20	0.57	0.41	0.21
	50 m	SFC	5.20	5.04	0.47	0.38	0.21
		BT	5.37	5.20	0.53	0.50	0.21
	100 m	SFC	4.72	4.55	0.53	0.53	0.18
		BT	5.53	5.20	0.53	0.41	0.18
South	25 m	SFC	5.20	4.88	0.47	0.44	0.21
		BT	5.20	4.88	0.57	0.41	0.18
	50 m	SFC	5.20	4.88	0.53	0.41	0.18
		BT	5.37	4.88	0.47	0.38	0.21
	100 m	SFC	5.20	5.20	0.53	0.41	0.18
		BT	5.37	5.20	0.53	0.41	0.18
East	25 m	SFC	5.37	5.20	0.50	0.34	0.18
		BT	5.37	5.20	0.53	0.31	0.18
	50 m	SFC	5.20	5.20	0.47	0.34	0.18
		BT	5.69	5.53	0.50	0.38	0.18
	100 m	SFC	5.53	5.53	0.53	0.38	0.18
		BT	5.53	5.37	0.53	0.41	0.18
West	25 m	SFC	5.04	4.88	0.53	0.34	0.18
		BT	5.20	5.04	0.67	0.59	0.18
	50 m	SFC	5.20	5.20	0.50	0.34	0.18
		BT	5.20	5.20	0.60	0.41	0.18
	100 m	SFC	5.37	5.04	0.53	0.31	0.15
		BT	5.20	5.04	0.57	0.25	0.15
Well Jacket		SFC	5.37	5.04	0.63	0.31	0.18
		BT	5.37	5.20	0.57	0.31	0.18

WATER COLUMN / PLATFORM B / FALL SAMPLING

STATION	DISTANCE		TSM (µg/L)	DOC (mgC/L)	POC (µgC/L)	δ^{13}C[POC] (°/oo)
North	25 m	SFC	453	1.02	52	-22.8
		BT	549	1.08	56	-22.7
	50 m	SFC	598	0.94	47	-
		BT	1017	1.02	59	-
	100 m	SFC	402	1.03	70	-
		BT	546	1.03	69	-
South	25 m	SFC	271	1.09	65	-22.2
		BT	582	1.21	66	-22.3
	50 m	SFC	274	1.08	66	-
		BT	964	1.18	68	-
	100 m	SFC	450	1.31	82	-
		BT	438	1.32	64	-
East	25 m	SFC	310	1.13	81	-23.1
		BT	638	1.18	80	-22.0
	50 m	SFC	349	1.23	62	-
		BT	950	1.10	94	-
	100 m	SFC	392	1.15	62	-
		BT	489	1.13	61	-
West	25 m	SFC	292	1.22	66	-23.9
		BT	294	1.18	53	-23.5
	50 m	SFC	353	1.25	64	-
		BT	778	1.18	75	-
	100 m	SFC	272	1.23	68	-
		BT	873	1.21	64	-
Flare Stack		SFC	635	1.15	67	-
		BT	479	1.21	74	-

WATER COLUMN / PLATFORM B / FALL SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	0.118	0.129	355	1.25
		BT	0.147	0.182	419	1.42
	50 m	SFC	0.078	0.137	359	1.25
		BT	0.133	0.096	425	0.00
	100 m	SFC	0.096	0.164	244	1.25
		BT	0.119	0.122	349	0.92
South	25 m	SFC	0.049	0.074	259	1.00
		BT	0.078	0.103	269	2.42
	50 m	SFC	0.091	0.138	166	1.67
		BT	0.105	0.130	295	2.25
	100 m	SFC	0.066	0.072	507	3.58
		BT	0.110	0.137	476	1.50
East	25 m	SFC	0.110	0.116	447	2.00
		BT	0.077	0.182	466	1.67
	50 m	SFC	0.125	0.145	379	1.83
		BT	0.133	0.149	246	3.83
	100 m	SFC	0.069	0.082	98	1.50
		BT	0.147	0.171	193	10.33
West	25 m	SFC	0.100	0.140	98	1.67
		BT	0.126	0.144	126	0.67
	50 m	SFC	0.091	0.117	98	<0.10
		BT	0.119	0.140	111	3.67
	100 m	SFC	0.145	0.127	494	0.58
		BT	0.135	0.118	320	<0.10
Flare Stack		SFC	0.127	0.087	422	4.25
		BT	0.122	0.149	218	4.67

WATER COLUMN / PLATFORM B / FALL SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	4.72	4.55	0.63	0.69	0.15
		BT	5.20	4.88	0.60	0.34	0.15
	50 m	SFC	4.23	4.23	0.53	0.25	0.15
		BT	5.20	5.04	0.53	0.31	0.18
	100 m	SFC	5.20	4.88	0.57	0.34	0.18
		BT	5.37	5.20	0.57	0.31	0.18
South	25 m	SFC	5.20	5.20	0.53	0.41	0.21
		BT	5.20	5.04	0.57	0.34	0.21
	50 m	SFC	5.20	4.88	0.57	0.31	0.18
		BT	3.58	4.07	0.47	0.38	0.18
	100 m	SFC	5.20	4.88	0.53	0.31	0.18
		BT	5.37	5.20	0.57	0.38	0.21
East	25 m	SFC	5.04	4.72	0.60	0.34	0.18
		BT	5.20	4.88	0.60	0.31	0.18
	50 m	SFC	5.04	4.88	0.63	0.34	0.18
		BT	5.04	4.88	0.53	0.38	0.21
	100 m	SFC	5.20	5.04	0.63	0.31	0.18
		BT	3.90	4.07	0.47	0.31	0.18
West	25 m	SFC	5.53	5.37	0.70	0.44	0.21
		BT	5.04	5.20	0.53	0.31	0.21
	50 m	SFC	5.20	5.20	0.63	0.31	0.21
		BT	5.04	4.88	0.57	0.34	0.21
	100 m	SFC	4.88	4.88	0.50	0.31	0.21
		BT	5.04	4.72	0.57	0.44	0.21
Flare Stack		SFC	4.88	4.88	0.57	0.31	0.18
		BT	5.04	4.88	0.57	0.31	0.18

WATER COLUMN / PLATFORM A / WINTER SAMPLING

STATION	DISTANCE		TSM (µg/L)	DOC (mgC/L)	POC (µgC/L)	$\delta^{13}C$[POC] (°/∘∘)
North	25 m	SFC	1176	1.65	176	-20.5
		BT	748	1.89	196	-21.3
	50 m	SFC	660	1.77	198	-
		BT	663	2.04	202	-
	100 m	SFC	1560	1.77	188	-
		BT	857	1.91	200	-
South	25 m	SFC	950	1.64	185	-22.5
		BT	1048	1.81	194	-20.9
	50 m	SFC	690	1.59	145	-
		BT	785	1.85	179	-
	100 m	SFC	720	1.62	198	-
		BT	862	1.94	209	-
East	25 m	SFC	1010	1.82	203	-23.5
		BT	872	1.99	174	-21.2
	50 m	SFC	853	1.62	185	-
		BT	1150	1.91	191	-
	100 m	SFC	908	1.65	176	-
		BT	924	1.61	188	-
West	25 m	SFC	760	1.78	196	-23.4
		BT	839	1.66	205	-21.6
	50 m	SFC	812	1.74	184	-
		BT	855	1.49	193	-
	100 m	SFC	1278	1.81	175	-
		BT	935	1.67	181	-
Well Jacket		SFC	707	1.83	216	-
		BT	710	2.18	183	-

WATER COLUMN / PLATFORM A / WINTER SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	CaCO$_3$ (μg/L)
North	25 m	SFC	1.802	0.685	186	<1.0
		BT	1.235	0.927	435	<1.0
	50 m	SFC	1.544	1.093	879	<1.0
		BT	1.651	0.744	671	<1.0
	100 m	SFC	1.596	1.172	896	<1.0
		BT	1.801	0.468	942	<1.0
South	25 m	SFC	1.651	0.492	688	<1.0
		BT	2.176	0.534	780	<1.0
	50 m	SFC	1.441	0.980	504	<1.0
		BT	1.951	0.570	986	<1.0
	100 m	SFC	1.699	1.112	716	<1.0
		BT	2.101	0.483	986	<1.0
East	25 m	SFC	2.251	0.900	716	<1.0
		BT	1.801	0.483	827	<1.0
	50 m	SFC	1.951	0.570	534	<1.0
		BT	2.026	0.747	1033	<1.0
	100 m	SFC	1.876	0.330	790	<1.0
		BT	2.401	0.813	1141	<1.0
West	25 m	SFC	1.647	1.055	506	<1.0
		BT	1.876	0.267	816	<1.0
	50 m	SFC	1.726	0.102	796	<1.0
		BT	2.101	0.546	209	<1.0
	100 m	SFC	1.576	0.189	809	<1.0
		BT	1.726	0.291	556	<1.0
Well Jacket		SFC	1.726	0.606	357	<1.0
		BT	1.493	1.102	912	<1.0

WATER COLUMN / PLATFORM A / WINTER SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	1.3	1.2	0.40	0.36	0.16
		BT	1.2	1.2	0.36	0.30	0.14
	50 m	SFC	1.3	1.2	0.36	0.33	0.14
		BT	1.3	1.2	0.36	0.33	0.14
	100 m	SFC	1.2	1.2	0.40	0.30	0.14
		BT	1.2	1.2	0.40	0.30	0.14
South	25 m	SFC	1.3	1.2	0.40	0.33	0.14
		BT	1.3	1.2	0.40	0.33	0.16
	50 m	SFC	1.3	1.2	0.40	0.33	0.16
		BT	1.3	1.3	0.40	0.40	0.16
	100 m	SFC	1.3	1.3	0.40	0.40	0.16
		BT	1.2	1.2	0.40	0.36	0.16
East	25 m	SFC	1.2	1.2	0.36	0.30	0.14
		BT	1.3	1.2	0.40	0.33	0.16
	50 m	SFC	1.2	1.2	0.36	0.30	0.14
		BT	1.3	1.3	0.40	0.33	0.16
	100 m	SFC	1.3	1.3	0.40	0.36	0.14
		BT	1.3	1.3	0.40	0.36	0.14
West	25 m	SFC	1.2	1.2	0.44	0.36	0.14
		BT	1.2	1.2	0.40	0.36	0.14
	50 m	SFC	1.2	1.2	0.40	0.36	0.16
		BT	1.3	1.3	0.40	0.36	0.16
	100 m	SFC	1.3	1.2	0.40	0.33	0.16
		BT	1.2	1.2	0.40	0.33	0.16
Well Jacket		SFC	1.2	1.1	0.40	0.36	0.16
		BT	1.2	1.1	0.44	0.33	0.16

WATER COLUMN / PLATFORM B / WINTER SAMPLING

STATION	DISTANCE		TSM (µg/L)	DOC (mgC/L)	POC (µgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	1019	1.99	155	-22.5
		BT	1000	2.05	186	-22.5
	50 m	SFC	1135	1.95	155	-
		BT	1100	1.90	170	-
	100 m	SFC	1292	1.82	185	-
		BT	1298	1.84	175	-
South	25 m	SFC	1236	2.26	117	-22.6
		BT	1100	1.83	122	-22.4
	50 m	SFC	1447	2.18	114	-
		BT	1422	1.59	133	-
	100 m	SFC	1100	2.14	119	-
		BT	1252	2.04	119	-
East	25 m	SFC	915	1.62	143	-23.2
		BT	972	1.54	157	-23.1
	50 m	SFC	935	1.52	154	-
		BT	1200	1.44	165	-
	100 m	SFC	815	1.50	139	-
		BT	933	1.78	142	-
West	25 m	SFC	803	1.88	185	-22.3
		BT	758	2.32	170	-22.4
	50 m	SFC	840	1.35	163	-
		BT	1409	1.88	171	-
	100 m	SFC	685	1.34	180	-
		BT	642	1.84	195	-
Flare Stack		SFC	890	1.88	230	-
		BT	897	1.69	193	-

WATER COLUMN / PLATFORM B / WINTER SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	2.101	0.735	561	<1.0
		BT	1.951	0.696	562	<1.0
	50 m	SFC	2.026	0.810	901	<1.0
		BT	2.176	1.038	838	<1.0
	100 m	SFC	2.026	0.495	1121	<1.0
		BT	2.176	0.219	946	<1.0
South	25 m	SFC	1.132	0.684	532	<1.0
		BT	1.416	1.179	509	<1.0
	50 m	SFC	0.978	0.600	605	<1.0
		BT	0.901	0.591	567	<1.0
	100 m	SFC	1.004	0.704	577	<1.0
		BT	1.004	0.639	558	<1.0
East	25 m	SFC	2.251	0.774	607	<1.0
		BT	2.101	0.609	1005	<1.0
	50 m	SFC	2.026	0.495	1018	<1.0
		BT	2.251	0.585	813	<1.0
	100 m	SFC	2.026	0.432	728	<1.0
		BT	1.951	0.444	842	<1.0
West	25 m	SFC	2.101	0.735	599	<1.0
		BT	1.951	0.381	916	<1.0
	50 m	SFC	2.026	0.873	835	<1.0
		BT	2.251	0.963	721	<1.0
	100 m	SFC	2.101	0.924	954	<1.0
		BT	2.101	0.672	930	<1.0
Flare Stack		SFC	2.026	0.873	709	<1.0
		BT	2.251	0.711	1113	<1.0

WATER COLUMN / PLATFORM B / WINTER SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	1.2	1.1	0.44	0.33	0.16
		BT	1.1	1.1	0.40	0.40	0.14
	50 m	SFC	1.1	1.1	0.36	0.30	0.16
		BT	1.1	1.1	0.40	0.33	0.16
	100 m	SFC	1.1	1.1	0.40	0.30	0.16
		BT	1.2	1.1	0.36	0.33	0.16
South	25 m	SFC	1.1	1.1	0.40	0.36	0.14
		BT	1.1	1.1	0.36	0.30	0.16
	50 m	SFC	1.1	1.1	0.40	0.36	0.19
		BT	1.1	1.1	0.36	0.30	0.16
	100 m	SFC	1.1	1.1	0.36	0.33	0.16
		BT	1.2	1.2	0.40	0.33	0.16
East	25 m	SFC	1.1	1.1	0.40	0.30	0.16
		BT	1.1	1.1	0.36	0.30	0.16
	50 m	SFC	1.1	1.1	0.40	0.33	0.16
		BT	1.1	1.1	0.36	0.33	0.16
	100 m	SFC	1.2	1.1	0.36	0.33	0.16
		BT	1.2	1.2	0.40	0.33	0.14
West	25 m	SFC	1.2	1.1	0.36	0.30	0.16
		BT	1.2	1.2	0.36	0.30	0.16
	50 m	SFC	1.2	1.1	0.36	0.30	0.16
		BT	1.1	1.1	0.40	0.26	0.16
	100 m	SFC	1.2	1.2	0.40	0.26	0.16
		BT	1.2	1.2	0.40	0.30	0.19
Flare Stack		SFC	1.2	1.1	0.40	0.33	0.16
		BT	1.1	1.1	0.40	0.30	0.16

WATER COLUMN / PLATFORM A / SPRING SAMPLING

STATION	DISTANCE		TSM (μg/L)	DOC (mgC/L)	POC (μgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	1736	1.17	258	-
		BT	2008	1.14	205	-
	50 m	SFC	1237	1.33	214	-
		BT	2467	0.89	199	-
	100 m	SFC	899	1.23	180	-
		BT	1986	0.90	89	-
South	25 m	SFC	650	1.21	126	-
		BT	1207	0.91	71	-
	50 m	SFC	971	0.83	131	-
		BT	1846	0.96	104	-
	100 m	SFC	627	1.06	133	-
		BT	1650	0.92	94	-
East	25 m	SFC	651	1.16	144	-20.6
		BT	1776	1.13	85	-
	50 m	SFC	664	1.17	122	-
		BT	1884	0.91	80	-
	100 m	SFC	689	1.08	114	-
		BT	2269	0.89	76	-
West	25 m	SFC	747	1.18	199	-
		BT	1364	1.09	83	-
	50 m	SFC	896	1.25	175	-
		BT	1187	1.11	82	-
	100 m	SFC	835	1.20	192	-
		BT	3297	0.97	122	-
Well Jacket		SFC	769	1.19	170	-
		BT	1400	0.87	93	-

WATER COLUMN / PLATFORM A / SPRING SAMPLING

STATION	DISTANCE		Chloro a (mg/m³)	Phaeophytin (mg/m³)	ATP (ng/L)	CaCO$_3$ (μg/L)
North	25 m	SFC	0.568 (0.568)	0.296 (0.284)	401 (397)	<1.0
		BT	0.551 (0.543)	0.290 (0.321)	1000 (976)	<1.0
	50 m	SFC	0.454 (0.454)	0.070 (0.085)	885 (873)	<1.0
		BT	0.706 (0.715)	0.306 (0.297)	706 (697)	<1.0
	100 m	SFC	0.307 (0.301)	0.083 (0.089)	659 (653)	<1.0
		BT	0.594 (0.586)	0.292 (0.290)	822 (817)	<1.0
South	25 m	SFC	0.680	0.229	437	<1.0
		BT	0.474	0.254	376	<1.0
	50 m	SFC	0.301	0.089	417	<1.0
		BT	0.465	0.262	602	<1.0
	100 m	SFC	0.363	0.086	618	<1.0
		BT	0.611	0.162	522	<1.0
East	25 m	SFC	0.758 (0.758)	0.254 (0.265)	592 (588)	<1.0
		BT	0.491 (0.500)	0.259 (0.251)	555 (561)	<1.0
	50 m	SFC	0.853 (0.844)	0.273 (0.270)	288 (286)	<1.0
		BT	0.534 (0.534)	0.273 (0.262)	210 (221)	<1.0
	100 m	SFC	0.307	0.068	631	<1.0
		BT	0.594	0.281	264	<1.0
West	25 m	SFC	0.272	0.222	380	<1.0
		BT	0.508	0.242	743	<1.0
	50 m	SFC	0.295	0.064	505	<1.0
		BT	0.577	0.298	297	<1.0
	100 m	SFC	0.431	0.093	594	<1.0
		BT	0.620	0.289	706	<1.0
Well Jacket		SFC	0.801	0.279	568	<1.0
		BT	0.525	0.270	394	<1.0

WATER COLUMN / PLATFORM A / SPRING SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	3.1 (3.3)	2.8	0.41 (0.37)	1.74 (1.79)	0.44 (0.46)
		BT	12.8 (12.9)	12.4	0.44 (0.41)	1.64 (1.64)	0.46 (0.42)
	50 m	SFC	3.8 (4.1)	3.7	0.26 (0.30)	2.87 (2.82)	0.52 (0.50)
		BT	13.1 (12.9)	12.8	0.37 (0.33)	1.74 (1.74)	0.44 (0.46)
	100 m	SFC	3.2 (3.8)	3.0	0.19 (0.22)	2.46 (2.56)	0.40 (0.42)
		BT	12.6 (12.4)	12.4	0.30 (0.33)	1.74 (1.79)	0.46 (0.46)
South	25 m	SFC	4.3	4.1	0.33	2.77	0.54
		BT	12.8	12.4	0.41	1.85	0.48
	50 m	SFC	4.1	3.8	0.33	2.92	0.52
		BT	12.9	12.8	0.33	1.74	0.44
	100 m	SFC	4.3	4.1	0.30	2.82	0.50
		BT	12.8	12.4	0.37	1.69	0.44
East	25 m	SFC	4.3 (4.5)	4.1	0.30 (0.33)	2.87 (2.82)	0.52 (0.50)
		BT	12.6 (12.8)	12.4	0.37 (0.37)	1.74 (1.79)	0.46 (0.46)
	50 m	SFC	4.7 (4.5)	4.5	0.30 (0.33)	2.87 (2.82)	0.50 (0.50)
		BT	12.9 (12.9)	12.8	0.37 (0.37)	1.74 (1.79)	0.46 (0.44)
	100 m	SFC	4.5	4.5 (4.5)	0.26	2.82	0.52
		BT	13.5	13.1 (12.9)	0.30	1.79	0.46
West	25 m	SFC	3.9	3.8	0.30	2.87	0.46
		BT	13.3	12.8	0.37	1.74	0.46
	50 m	SFC	3.8	3.8	0.33	2.77	0.48
		BT	13.5	13.1	0.37	1.74	0.46
	100 m	SFC	3.8	3.8	0.33	2.87	0.48
		BT	13.5	13.1	0.37	1.69	0.46
Well Jacket		SFC	3.9	3.8 (3.8)	0.30	2.82	0.52
		BT	13.5	13.1 (13.3)	0.33	1.74	0.48

WATER COLUMN / PLATFORM B / SPRING SAMPLING

STATION	DISTANCE		TSM (μg/L)	DOC (mgC/L)	POC (μgC/L)	$\delta^{13}C$[POC] (°/₀₀)
North	25 m	SFC	890	1.29	130	-
		BT	1659	0.80	85	-
	50 m	SFC	918	1.46	126	-
		BT	1677	1.05	84	-
	100 m	SFC	770	1.45	126	-
		BT	1885	0.88	90	-
South	25 m	SFC	1314	1.28	142	-
		BT	1405	1.00	103	-
	50 m	SFC	594	1.28	145	-
		BT	904	1.05	119	-
	100 m	SFC	805	1.37	142	-
		BT	1497	0.92	105	-
East	25 m	SFC	934	1.18	150	-18.3
		BT	1624	1.05	105	-21.0
	50 m	SFC	895	1.21	156	-
		BT	1702	1.10	91	-
	100 m	SFC	697	1.50	142	-
		BT	1407	1.11	94	-
West	25 m	SFC	602	1.46	211	-
		BT	1387	1.11	86	-
	50 m	SFC	706	1.30	188	-
		BT	1492	1.03	89	-
	100 m	SFC	711	1.32	162	-
		BT	1929	1.08	110	-
Flare Stack		SFC	754	0.91	137	-
		BT	1641	1.00	97	-

WATER COLUMN / PLATFORM B / SPRING SAMPLING

STATION	DISTANCE		Chloro a (mg/m^3)	Phaeophytin (mg/m^3)	ATP (ng/L)	$CaCO_3$ (µg/L)
North	25 m	SFC	0.284	0.091	171	<1.0
		BT	0.654	0.414	387	<1.0
	50 m	SFC	0.301	0.081	1134	<1.0
		BT	0.568	0.341	375	<1.0
	100 m	SFC	0.312	0.107	306	<1.0
		BT	0.508	0.276	141	<1.0
South	25 m	SFC	0.318	0.090	1375	<1.0
		BT	0.465	0.285	244	<1.0
	50 m	SFC	0.295	0.094	484	<1.0
		BT	0.655	0.346	313	<1.0
	100 m	SFC	0.295	0.102	389	<1.0
		BT	0.534	0.330	754	<1.0
East	25 m	SFC	0.295	0.094	555	<1.0
		BT	0.465	0.308	416	<1.0
	50 m	SFC	0.352	0.098	488	<1.0
		BT	0.594	0.395	311	<1.0
	100 m	SFC	0.329	0.090	254	<1.0
		BT	0.663	0.371	374	<1.0
West	25 m	SFC	0.539	0.173	455	<1.0
		BT	0.250	0.137	355	<1.0
	50 m	SFC	0.431	0.123	373	<1.0
		BT	0.353	0.181	924	<1.0
	100 m	SFC	0.818	0.330	171	<1.0
		BT	0.465	0.240	173	<1.0
Flare Stack		SFC	0.491	0.294	766	<1.0
		BT	0.324	0.296	179	<1.0

WATER COLUMN / PLATFORM B / SPRING SAMPLING

STATION	DISTANCE		Total SiO_2 (μM)	Dis. SiO_2 (μM)	Phosphate (μM)	Nitrate (μM)	Nitrite (μM)
North	25 m	SFC	4.5	4.1	0.44	2.97	0.54
		BT	13.1	12.8	0.44	1.49	0.48
	50 m	SFC	4.9	4.5	0.37	3.38	0.54
		BT	13.1	12.9	0.44	1.64	0.48
	100 m	SFC	4.9	4.5 (4.7)	0.41	3.33	0.52
		BT	13.5	13.3 (13.1)	0.44	1.64	0.48
South	25 m	SFC	4.9	4.7	0.44	3.38	0.60
		BT	12.0	11.6	0.44	1.64	0.52
	50 m	SFC	5.3	4.5 (4.7)	0.41	3.59	0.63
		BT	12.0	11.6 (11.6)	0.41	1.85	0.52
	100 m	SFC	4.9	4.5	0.37	3.28	0.58
		BT	14.1	13.5	0.37	1.69	0.50
East	25 m	SFC	4.5	4.5	0.41	3.18	0.56
		BT	13.5	13.1	0.44	1.69	0.50
	50 m	SFC	4.3	4.1	0.41	3.33	0.54
		BT	13.9	13.5	0.37	1.64	0.50
	100 m	SFC	4.5	4.5 (4.5)	0.33	3.23	0.56
		BT	12.8	12.8 (12.6)	0.37	1.74	0.52
West	25 m	SFC	3.9	3.8	0.33	3.28	0.52
		BT	4.9	4.5	0.33	1.08	0.31
	50 m	SFC	3.6	3.6	0.37	2.51	0.52
		BT	6.0	5.6	0.33	1.33	0.38
	100 m	SFC	4.7	4.5 (4.5)	0.30	3.28	0.56
		BT	13.1	12.8 (12.8)	0.37	1.74	0.48
Flare Stack		SFC	4.5	4.5 (4.3)	0.33	3.28	0.54
		BT	13.9	13.5 (13.1)	0.37	1.54	0.48